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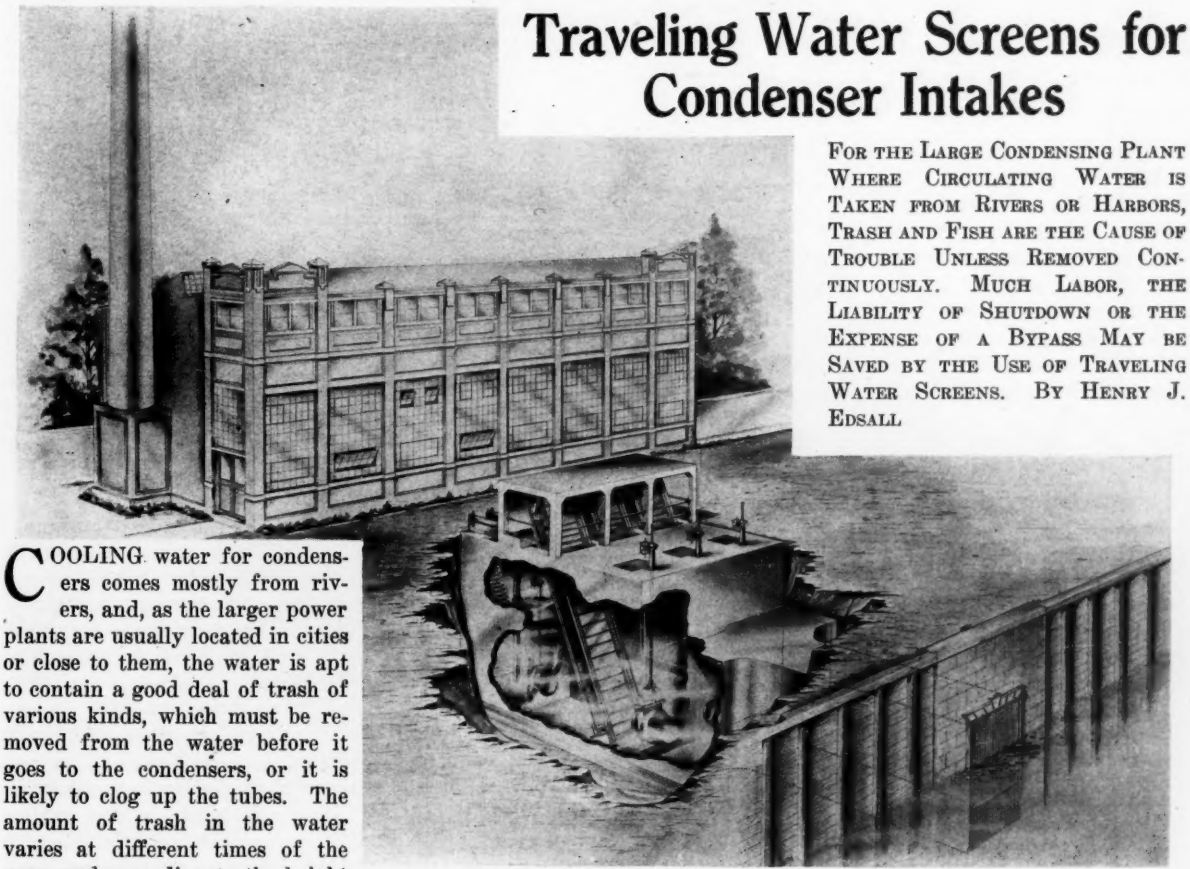
Traveling Water Screens for Condenser Intakes

FOR THE LARGE CONDENSING PLANT WHERE CIRCULATING WATER IS TAKEN FROM RIVERS OR HARBORS, TRASH AND FISH ARE THE CAUSE OF TROUBLE UNLESS REMOVED CONTINUOUSLY. MUCH LABOR, THE LIABILITY OF SHUTDOWN OR THE EXPENSE OF A BYPASS MAY BE SAVED BY THE USE OF TRAVELING WATER SCREENS. BY HENRY J. EDSALL



COOLING water for condensers comes mostly from rivers, and, as the larger power plants are usually located in cities or close to them, the water is apt to contain a good deal of trash of various kinds, which must be removed from the water before it goes to the condensers, or it is likely to clog up the tubes. The amount of trash in the water varies at different times of the year, and according to the height of the water in the stream. In the fall when the leaves are dropping from the trees is about the worst time, since a leaf or small piece of paper, if plastered across the end of a small diameter condenser tube, will stop up the tube effectively and prevent the flow of water through it.

Until recently it has been the custom to use stationary screens, usually two of them, one in front of the other, these screens sliding down between guides in the rectangular intakes so that the water has to pass through them to get to the condensers. If the trash is allowed to collect on these screens, it gradually cuts down the amount of water which will flow through them, so that unless there is a large excess of area for the amount of water required, the screens soon become so clogged that the condensers do not get the proper amount of water for efficient condensing. In any case, it is necessary to raise the stationary screens at intervals, depending upon the condition of the water, and remove the trash from them in order to allow the water to flow freely through them. In large power plants this necessitates considerable labor, especially when the water is in bad condition, and in one large power plant in Philadelphia the screens used to require as many as 6 men to keep them in proper condition when the water was full of trash. In addition to this, the raising and lowering of the fixed screens allows a certain amount of trash to get past and the mesh of the wire cloth of the fixed screens is ordinarily made larger than it should be, to avoid frequent cleaning. This makes it necessary to clean the condensers oftener and, in order to make them easily accessible for cleaning, expensive bypass arrange-

ments are installed so that a condenser can be easily cut out and opened up.

If this cleaning of the condensers is neglected, it not only cuts down their efficiency but, by having the tubes stopped up, the force of the water from the pumps presses with added force against the heads and a crack is likely to result. The amount of work required to clean the screens and condensers and the fact that the condensers do not get a sufficient supply of water if this work is neglected, has led engineers to look around for some mechanical method of keeping the screens cleaned off and in proper operating condition. Since the trash is apt to cling quite closely and some of it even stick through the holes in the screens, it was obviously out of the question to leave the screens stationary and try to arrange for brushing the trash off. The most satisfactory method and the one which is fast becoming standard practice is to make the screens travel like an endless belt, the lower end being at the bottom of the intake basin and the upper end somewhat above ground level.

FIG. 1. TRAVELING WATER SCREEN SHOWING GENERAL CONSTRUCTION

This brings the screens to a suitable height for discharging the trash and makes them accessible.

In order to wash off the trash which will not fall off by gravity, a perforated pipe is placed just back of the inside of each screen and water forced through it at considerable pressure so as to force the trash out of the meshes of the wire and let it fall off into a trough or other receptacle. This method has proved very effective in cleaning and if there are any sticks or other pieces of trash which still cling to the screens they can be easily removed by one attendant. In order to make it easier to get a trough or other receptacle well in under the heads of the machines so that the trash will fall into it and not back down into the intake, the screens are usually inclined at an angle of about 60 deg.

As it was not feasible to bend the wire screen cloth itself around the head and foot wheels it became necessary to divide it up into sections and attach these sections to frames and then, in order to arrange for the moving of these frames, they were attached to two strands of chain running over sprocket wheels at head and foot. The frames are fitted to the chains so as to come close together and not allow the trash to get through between them and the chains themselves travel

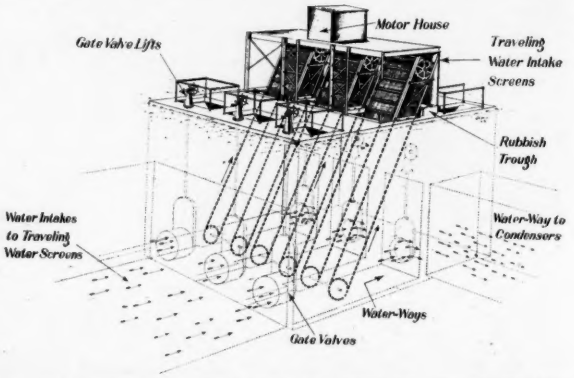


FIG. 2. TYPICAL SCREEN INSTALLATION OF MODERATE SIZE

up and down in guides, which also serve to form a protection to keep the trash from going through between the links of the chain.

The usual construction is to make the chains of 12 or 18-in. pitch steel strap chain with steel pins and cast-iron rollers at the joints. The length of the frames, which determines the width of the screens, can be varied to suit the requirements; but this length is ordinarily not over 5 or 6 ft., since, if the frames are too long, they are apt to get out of shape. The frames themselves are made of steel angles or flats and the screen cloth is bolted to them. The screen cloth wire is of brass, copper, galvanized iron or soft iron, and the usual size of openings is ½ in. square.

Where there is more than one screen, each screen is usually set in a separate compartment with valves for shutting off the flow of water where it comes into the compartment and also where it goes out, so that it is possible to shut this compartment off completely and pump the water out in case repairs to the screen are necessary. The head and foot shafts and guides can also be supported on a self-contained frame so that the whole frame and screen can be taken out bodily for repairs and replaced by a spare screen if one is kept on hand.

One or more screens can be driven by a single electric motor and as the speed of travel of the screens is very slow, usually only about 9 ft. per min., it is necessary to gear down from the speed of the motor to a speed for the head shaft of the screen of about one r.p.m. The simplest and most effective method of doing this is to use a differential speed reducing device, employing either silent chain and wheels or spur gears. Very little power is required for the operation of the screens

on account of the slow speed and because it is necessary only to overcome friction which is kept quite low by the large rollers of the chains. In operating the screens they are, as a rule, run only at intervals and only long enough each time to get them properly cleaned off. The frequency of operation necessary depends upon the condition of the water.

A good idea of the general construction of one of these screens is given in Fig. 1. This shows the screen frames made of steel angles and attached to 2 strands of steel strap chain running around sprocket wheels at head and foot and also shows the steel guides for the chain and a self-contained steel frame for supporting the head and foot shafts, this frame being arranged so that it can be bolted in place and removed bodily when desired. Figure 2 is an illustration of a typical screen installation of moderate size, which is now under construction for the Citizens Gas & Electric Co., Waterloo, Iowa. In this case the forebay is divided up into 3 compartments for 3 screens and the valves at the inlet and outlet of each compartment are clearly shown. The screen frames are built of 2½ by 2 by ¼-in. angles and they are 4 ft. 1 in. long by 16¾ in. wide. The chains

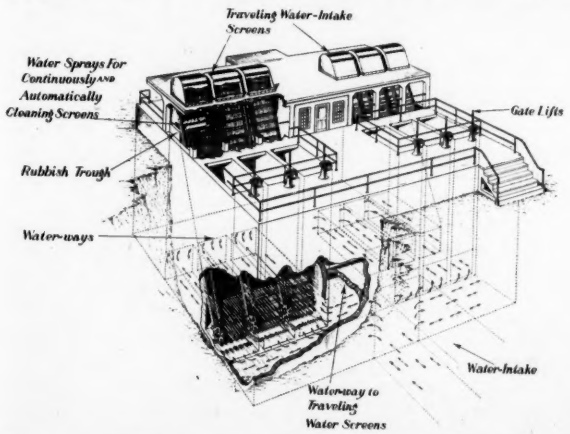


FIG. 3. SCHEME OF WATER SCREENS AT PHILADELPHIA ELECTRIC CO.'S PLANT

are 18-in. pitch with a 3¼-in. roller at each joint running on the outside of a bushing fitted to the inside links and there are 1-in. rods which run all the way through, and which are journaled where they go through the chains, and the outside ends milled off flat so that the rods turn with the outside links instead of having the links turn on the rod. This gives a large bearing surface in the joint and prevents wear on the links, and the rods help to tie the chains together accurately.

The wire screens are bent up on the edges and clamped to the inside of the angle frames by means of steel flats and bolts, these bolts having countersunk heads for the sides of the frames and for the bolts at the ends which attach the frames to the chains. The flats on the lower side of the screen frames extend out beyond the angles and are bent to form a bucket to carry up the trash and there is also an additional plate riveted underneath which extends across the gap between the frames and closes this up so that trash cannot get through between. Each screen unit is 30 ft. center to center of head and foot wheels and the sprockets are 36 in. piston diameter. Each screen is geared with spur gears to a counter shaft, which in turn is driven from a jack shaft by means of a chain drive, with jaw clutches for throwing the chain drive in or out, and the jack shaft is connected to a motor by means of a speed reducing device. The jack shaft runs at a speed of about 23½ r.p.m., the head shaft at a speed of 1 r.p.m., and this means a little over 9 ft. per min. travel for the screens.

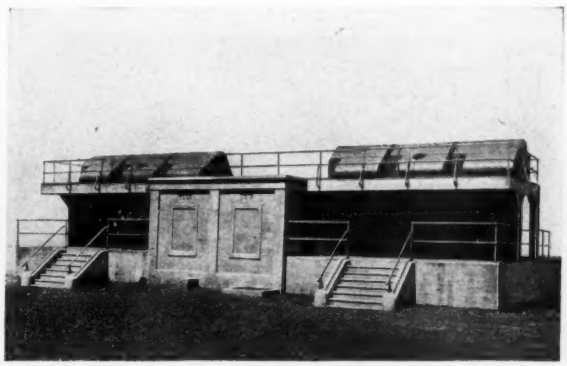


FIG. 4. FRONT VIEW OF WATER SCREEN INSTALLATION AT PHILADELPHIA ELECTRIC CO.'S PLANT

Figures 3 and 4 show a traveling water screen installation for the principal power station of the Philadelphia Electric Co., in Philadelphia, this station being divided up into two and known as stations A-1 and A-2. In this case there are 6 screens, each having an effective

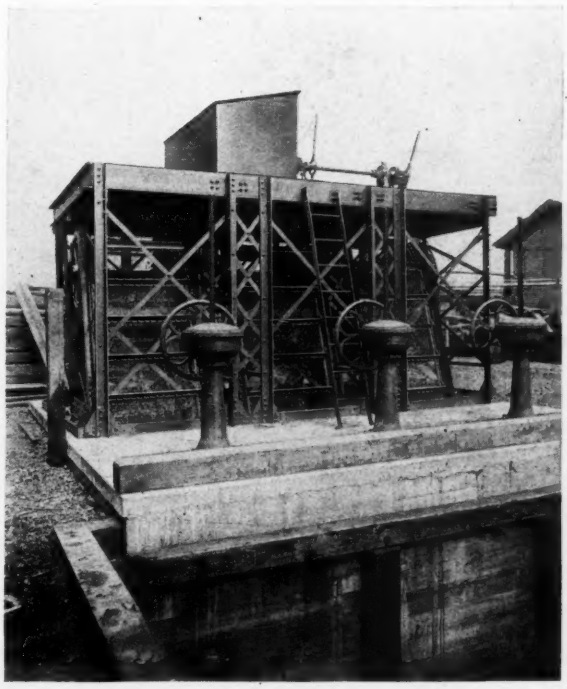


FIG. 5. INSTALLATION OF WATER SCREENS AT CHESTER, PA.

width of screening surface of about 5 ft., so that the total width of screening surface of the 6 screens is about 30 ft. The condensers at this plant require about 411,000,840 gal. of water in 24 hr., when running under full load. The screen frames in this case are made of

⅜ by 2-in. steel flats bent into rectangular form and welded together and the wire screens are made of No. 10 Birmingham gage galvanized wire, ½-in. mesh. These wire screens are bent up at the edges and attached to the frames by means of ½-in. bronze bolts with steel washers under the nuts. The plates which are attached to the steel frames, to form the ledges for taking up the trash, are 3/16-in. steel plates 4 in. wide. The chains are 18-in. pitch steel strap chains with ¾-in. cold rolled steel pins and 4½-in. diameter cast-iron rollers with Tobin bronze bushings, these bushings revolving on the steel pins. The sprocket wheels at the head and foot are 41½-in. diameter 7-tooth wheels, all keyed to the shafts, which run in babbited bearings, no provision being made for oiling the foot bearings under water, as this does not seem to be necessary. The shafts are made of nickel steel in order to avoid corrosion as far as possible. Each head shaft is driven by means of a

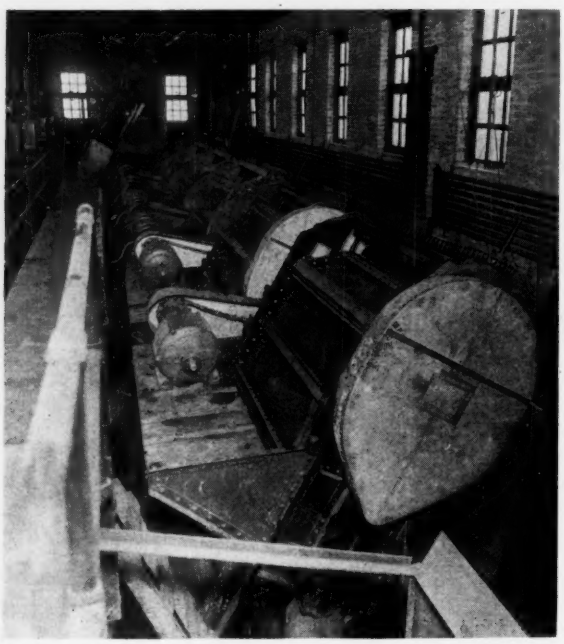


FIG. 6. MOTOR DRIVEN INTAKE SCREENS AT THE NORTHWEST STATION, COMMONWEALTH EDISON CO., CHICAGO

chain drive from a counter shaft, and the counter shaft is connected through a reducing gear to a 5-hp. motor. The spray pump for delivering the spray for cleaning the screens is located in the concrete house between the 2 sets of 3 screens each and this pump has a capacity of 500 gal. per min. It operates the spraying nozzles on 3 screens at a time.

Figure 5 shows an installation of 3 traveling screens for the Beacon Light Co., Chester, Pa. The valve operating wheels are clearly shown in front of the screens and the house for the motor which operates the 3 screens is shown on top of the framework. The general construction of the screens is very similar to the ones described above, but the screen cloth used in this case is made with copper wire.

Traveling screen installations of this type not only save the majority of the labor necessary for keeping the screens clean, but they save labor necessary for cleaning condensers, since this cleaning does not have to be done so frequently, and they also increase the efficiency of the condensers, which results in better condensation and saving of coal. One large power company states that by installing the traveling screens they consider that they get rid of the necessity of installing the expensive bypass arrangements around the condensers and that by this elimination they save enough in cost to pay for the traveling screen installation.

These traveling screens have been carefully perfected and are fast becoming standardized; they are being used in practically all new power plant installations of any size and are also displacing many of the stationary screens in the older plants.

AT THE Fourth National Foreign Trade Convention recently held in Pittsburgh, where over 1300 delegates were present, representing all activities in foreign commerce, a declaration of the essential principles of foreign trade policies was adopted covering the following points:

The chief requirement for American success in foreign trade depends upon the efficiency of production and enterprise in trade methods, and upon the relief by the government from disadvantages imposed by its own legislation, and protection by governmental action from discrimination in foreign markets.

Trade must depend primarily for future development on the efficiency of agricultural and industrial production, the enterprise of American manufacturers, merchants and bankers, and the training of our youth in schools, college and universities. Wider distribution of the benefits of foreign trade depends upon the participation of a steadily increasing number of industries and enterprises of moderate size, and governmental agencies, such as the Department of State, including consular service, the Department of Commerce, Federal Reserve Board and the Federal Trade Commission, can assist by negotiating advantageous commercial treaties, and collecting and disseminating information in regard to foreign markets, improved methods of financing, selling and purchasing. But to meet world competition, American business must be relieved of disadvantages imposed by legislation, and must be protected from possible discrimination in foreign markets.

The national shipping policy must be developed so as to increase the national income and domestic prosperity by greater facilities for selling our products abroad, and for importing foreign materials and products needed here. Transportation service must be developed, under the American flag, with foreign countries and with the possessions of the United States, and national defense must be aided, and our foreign commerce maintained in its rights.

New commercial treaties must be negotiated, as those under which the world's trade was conducted previous to August, 1914, are no longer in effect, and such treaties must take account of the new commercial alliances which will be formed among European nations. These treaties and the carrier system should be so arranged as to assure the continuance of the favorable treatment which the United States received before the war, and to protect American exports against discrimination, which seems to require that Congress adopt the principle of a flexible or bargaining tariff.

Handling Lubricants---I

STORAGE AND CHECKING METHODS FOR LUBRICANTS USED IN POWER PLANTS AND INDUSTRIAL MILLS. BY JOHN ROME BATTLE*

COST of power plant and industrial mill lubrication has been found to be directly proportional to the relative efficiency, of the methods in use, for the checking and recording of the amount of the oils received and used in the operation under investigation. The lubricating cost is also greatly decreased by improved design and arrangement of the oil storage facilities. These facts should be of interest to every operating engineer and power plant manager who is interested in reducing the lubricating cost in his plant, increasing the efficiency and decreasing the wastage of the lubricants used.

It is unfortunate that the average engineer does not have a greater opportunity to visit a large number of power plants, other than his own, for the purpose of comparing the relative efficiency of lubrication, from the standpoints of economy and neatness, that can be directly traced to the methods in use in these plants, for the measuring, accounting and storage of the lubricants used.

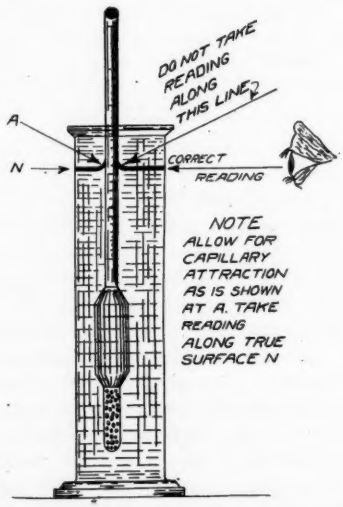

DO NOT TAKE READING ALONG THIS LINE
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FIG. 1. METHOD OF USING THE HYDROMETER

The operating engineer of even the small plant using from 6 to 10 bbl. of lubricating oil a year, will be well repaid for the time spent in carefully considering his subject. His problems can be solved with as much satisfaction as can be obtained in the large plant using many hundreds of barrels of oil a year.

Careful thought in laying out the space given over to the oil storage will not only increase the economy of lubrication, due to the reduction in waste, but will also result in a much cleaner plant.

In the following paragraphs I will outline some successful methods of oil accounting and storage that are in use in a well designed small plant and a large industrial operation.

SMALL PLANT

THE FIRST step to be taken in the study of oil storage methods for a small plant should be to systematize the arrangements for checking the number of gallons of the oils as they are received from the oil company.

By far the best and simplest method of checking the amount of oil, when the oil is received in a barrel or can, is by the "Weight-Gravity Method." This method is briefly described as follows:

EQUIPMENT REQUIRED

1. Standard platform scales.
2. A hydrometer and thermometer combined.
3. A hydrometer jar.
4. A gravity-weight table, with gallons shown.

DESCRIPTION OF THE OPERATION OF THE METHOD

THE BARREL, as it is received from the oil company, is weighed on the platform scales. This weight is noted as the gross weight, (W_1).

The barrel is then emptied by draining bung down for at least an hour for a fairly heavy oil, or until the oil has been thoroughly drained from the barrel. The empty barrel is next weighed and this weight is noted as the net weight, (W_2).

While the barrel is being emptied the gravity of the oil should be noted. A sample of the oil which is draining from the barrel is taken. About a half pint is

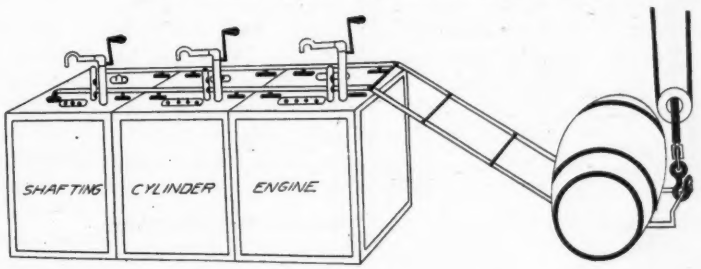


FIG. 2. CONVENIENT ARRANGEMENT FOR HANDLING BARRELS OF OIL

required for this purpose, and the method of taking the gravity is as follows: A glass jar, called a hydrometer jar, is filled with the oil to a level of about 2 in. from the top. The hydrometer is placed in the oil very gently to avoid bobbing and allowed to come to rest, floating free from the sides of the jar. The temperature of the oil should then be noted by means of the thermometer which is combined with the hydrometer, and at the same time the graduation on the stem of the hydrometer, which is directly in line with the true surface of the oil, is noted. Capillary attraction may cause the surface of the oil to be slightly raised or depressed in the area around the stem of the hydrometer, as is shown in Fig. 1, and the reading should be made with the line of sight along the surface of the oil, as is shown in the figure, and if necessary an approximation may be made as to the exact point at which the oil surface would strike the stem of the hydrometer if there was no capillary attraction. The reason for inserting the hydrometer into the oil carefully is to avoid any bobbing and the consequent adhering of oil to the hydrometer stem, which would be carried above the surface of the

*Author Battle's Handbook for Lubricating Engineers.

oil when the hydrometer has finally come to rest. This would, of course, add weight to the hydrometer and cause the reading to be affected.

The purpose of taking the temperature of the oil when the gravity reading is taken, is to correct the reading so that it will be referred to a standard temperature of 60 deg. F. (In order to have a standard temperature for the comparison of oil gravities, the oil trade has adopted 60 deg. F. as the temperature at which the gravity readings are to be taken.) The density and therefore the gravity, of oil is reduced or increased as its temperature is reduced or increased, and it will be necessary for the engineer to refer to the "Temperature-Gravity" table, as given below, to correct the gravity reading as taken from his oil.

TABLE FOR MAKING TEMPERATURE-GRAVITY CORRECTIONS

Baumé Gravity	45 Deg.	50 Deg.	60 Deg.	65 Deg.	70 Deg.	75 Deg.
20	20.8	20.6	20.0	19.7	19.4	19.1
22	22.8	22.5	22.0	21.7	21.4	21.1
24	24.9	24.6	24.0	23.7	23.4	23.1
26	26.9	26.6	26.0	25.7	25.4	25.1
28	29.0	28.6	28.0	27.7	27.3	27.0
30	31.0	30.7	30.0	29.7	29.3	29.0
32	33.1	32.7	32.0	31.6	31.3	30.9
34	35.1	34.8	34.0	33.6	33.3	32.9

As a typical example of the use of the above table: Suppose the gravity of a sample of oil was taken when the temperature, as recorded by the thermometer, was 75 deg. F., and the hydrometer reading was 29.0. Then by referring to the table, the gravity at 60 deg. F. can be seen to be 30.0 Baumé.

After the correct gravity has been found, the next step in checking the number of gallons is to refer to the Gravity-Gallons Table herewith, so that the weight of the oil per gallon can be determined.

TABLE GRAVITY BAUMÉ AND CORRESPONDING WEIGHTS PER GALLON

Baumé Gravity	Weight per Gallon (In Pounds)
20.0	7.772
22.0	7.670
24.0	7.570
26.0	7.473
28.0	7.378
30.0	7.286
32.0	7.196
34.0	7.196

By the use of simple arithmetic the correct number of gallons of the oil can now be determined in the following order:

W_1 = Weight of barrel and oil.
W_2 = Weight of barrel empty.
W_3 = Weight of one gallon of the oil as determined by the gravity.

Then—

$(W_1 - W_2) \div W_3$ = correct number of gallons of oil received.

Many advantages will result from this method of checking. There is little opportunity of making a mistake in the result, and there should be no loss from waste, as is often the case when the delivery is checked by the use of 5 or 10-gal. measure. The temperature of the air has no effect on the accuracy of the result, as the same standard temperature is used, both in summer and winter.

Another advantage which is offered by this method is the check it gives on current deliveries. While the gravity of a lubricating oil is no indication of its value as a lubricant it does serve as a check in determining that the same kind of oil is being delivered each time. It is well to compare the gravity of each barrel with that of the preceding deliveries.

If a record of the delivery is desired, it is a good plan to have a form similar to the one suggested herewith, made up in the form of a cheap pad for convenience.

OIL DELIVERY CHECKING FORM

Date.....191....
Delivered by.....
Weight of barrel filled.....pounds
Weight of barrel empty.....pounds
Net weight of oil.....pounds
Gravity of oil at.....F. .....Baumé
Corrected gravity at 60 deg. F. .....Baumé
Weight of oil.....pounds per gallon at 60 deg. F.
Net weight of oil (.....)
Weight of oil per gallon (.....) = (.....) [gallons / [delivered
Delivery checked by.....

These forms can be printed on the office mimeograph, or a rubber stamp may be used if it is not thought suitable to have them printed.

After having decided upon the method of checking the deliveries of the oil, the next consideration must be given to its proper and economical storage.

If the plant is equipped with a circulating oiling system for the engine and dynamo oil the usual custom is to pour the new oil directly into the main tank of the circulating system. This plan can be improved upon, however, by providing a separate tank for the reserve oil and by keeping a record of the amounts of oil drawn from this reserve tank for use in the system. In this manner the amounts of oil used each week can be recorded for reference. A good plan is to provide a cheap memorandum book, which should be kept hanging by a string near the tank, and to enter the amount of each lot of oil at the time it is taken out. By referring to this record the amount of lubricating oil used per horsepower-day can be frequently figured and some valuable information obtained.

The storage or reserve tank should always be fitted with a good strainer, through which all of the oil should be poured when running it from the barrel.

The only efficient method of emptying oil barrels is by gravity. A good arrangement for use in an average sized plant is shown in Fig. 2. The cradle and hoist are used to lift the barrel up to the track which runs over the top of the tanks and the barrel can be rolled to the desired tank and allowed to drain thoroughly. An apparatus, such as is shown, works in well with the checking plan, as the barrel can be rolled directly from the scales to the hoisting cradle, then rolled to the desired tank, drained, and with a minimum of effort returned to the scale for re-weighing.

The storage tanks should always have a sufficient factor of safety, as to their capacity, to provide for a good reserve supply of oil. It is usual for the consumer to call on the oil company for an immediate delivery of some grade of oil that is necessary for running the engines or equipment of his plant, and of which the supply has been allowed to become exhausted. This places an unnecessary demand on the oil company, which may result in disappointment for the consumer.

Storage tanks for cylinder oils should be located in a warm room to facilitate the draining of the barrels and the removal of oil from the tanks as required.

It is a good plan to place a steam coil in the lower part of the cylinder oil tank, so as to provide a means for thinning out the oil in cold weather. The steam coil must in all cases be connected with the exhaust steam pipe and never with a main supplying live steam. Live steam, if sufficiently high in pressure, will be so hot that it will cause the partial destruction of the oil if used in the heating coil.

Storage tanks should in all cases be located with a view to convenience and accessibility. It is easier to roll a barrel a few feet farther to a well located storage tank than to be required to make many extra steps for the current lots of oil. It is common to find storage tanks so badly located that the oil must squeeze in between various other tanks or equipment to get a supply of oil, and often the tank is located in a badly lighted room. It is surprising how much oil is wasted due to poor storage equipment.

In a small plant where the tanks are small and it is desired to warm the oil slightly, it is a good plan to suspend an incandescent light or two from a well insulated wire in the oil. This will make an efficient heater.

In many plants the wooden barrels in which the oil is delivered are used to store the oil in. This is a practice that is not to be encouraged because the glue with which the barrels are coated on the inside may become soft and mix with the oil, causing it to foul. If it is found to be necessary to use the barrels for storage they should always be stored on their sides and should be laid on skids. The skids should be laid about 15 in. apart, so that they will support the barrels at their strongest points, which are near the quarter hoops.

When emptying oil barrels they should be allowed to drain for as long a time as is possible in order to empty them thoroughly. It would be surprising to the consumer if he could see the large amount of oil which is returned to the oil company through the medium of badly drained barrels. Often as much as a gallon or more of the oil remains in the barrel and the consumer should appreciate that he has paid for this oil.

Care should be taken to prevent unnecessary damage to wooden barrels. The cost of lubrication is of course directly affected by the amount returned by the oil company for the return of the empty barrels, and as the paying prices offered by the oil company are dependent upon the condition of the barrel, it will be to the interest of consumers to observe the following rules regarding the care of the barrels:

(a) Broken heads or staves will result in dockage at a fixed rate.

(b) The bung hole should never be drilled to a larger diameter than 1¼ in. or the barrel will be docked for the entire stave.

(c) The bung should be removed with a bung pick and never driven into the barrel as this operation is likely to split the stave.

(d) When boring a vent hole, it should be located at least 2 in. from the inside of the stave if the vent is to be in the head of the barrel.

Considerable saving will result if the above rules are observed.

The market prices paid for wooden barrels fluctuate with the supply and demand, and the large oil companies issue printed lists showing the paying prices for the various classes of barrels.

(To be concluded.)

Plunger Pump Packing

REDUCING FRICTION AND ACTION OF DIFFERENT STYLES OF PACKINGS ON OUTSIDE PACKED PLUNGERS. BY J. C. HAWKINS

IN some cases where an outside packed plunger pump is used for boiler feeding, considerable trouble is experienced with the packing. In this type of pump there are 4 comparatively large surfaces to be repacked. If packing is not properly put in or the wrong kind of packing is used, it will cause a great amount of friction and the steam consumption of the pump will be much higher than it should be. Where a proper packing is used, very little gland pressure is required, consequently the friction of the packing is low. When the outside packed pump is to be used alternately for hot and cold water, considerable trouble may be had on account of the expansion and contraction of the packing.

Some time ago, the writer had considerable trouble with this type of pump, a 12 by 7 by 12-in., which was used principally for boiler feeding, but in case of an emergency, was used to pump cold water into the stand pipe. When he took charge of the plant, the plungers were packed with ⅞-in. square flax packing which had to be drawn up very tight to prevent leakage when pumping hot water at 210 deg. against 165 lb. feed line pressure.

When it was switched over to the high-pressure tank service with about 18 or 20 ft. lift and 270 ft. head pressure, it was necessary to draw the packing up as tight as possible to get the water, and sometimes the packing was so tight and dry that the plungers would stick until considerable pressure had accumulated in the steam cylinder, when the plungers would move with a jump and the steam piston would strike the cylinder head. Two cylinder heads and one piston was broken in this manner.

After some months of this kind of trouble, the dimensions of the stuffing box were sent to a packing company and we put in a set of packing that was made especially for this type of pump and which is shown in the sketch, Fig. 1.

The set consisted of 2 rings of cushion center hydraulic placed in the bottom of the box to carry the weight of the plunger, then 1 ring of diagonal packing, 1 ring of hydraulic, 1 ring of split and 2 rings of hydraulic on top. Only one of the last rings could be put in when the packing was new, but the second was put in later.

This hydraulic is a canvas and gum packing lubricated with graphite. The packing was put in place and the glands screwed up finger tight only. In order to determine what, if any, reduction of steam was made in the operation of the pump after changing the packing, a gage was connected to the steam chest of the pump, which with the square flax packing on the plungers and the pump running at normal speed required 85 lb. steam pressure to operate the pump. After the special packing was put on, the required steam pressure dropped to 55 lb. to do the same work, which showed a difference in packing friction equal to 30 lb. steam pressure on the steam piston.

Further, it was possible to change over from hot to cold water or vice versa without any trouble with the plungers sticking or leakage, because the expansion and contraction were taken care of by the split rings, and there was little friction. This change of temperature, however, is not conducive to long life of packing. It was the practice, no matter what kind of packing was used, to "dope" the plungers 2 or 3 times a day with a little cylinder oil with which a little graphite had been mixed.

The advantages of this sectional packing, of which there are several kinds, are two. First, it is self adjusting, and the water pressure against the bottom rings which carry the weight of the plunger causes the wedges to slide one over the other and makes a tight joint between the box and the plunger, which is also assisted by the solid pliable rings. On the suction stroke when the plunger is working against low pressure the wedges move apart so that there is little friction on the plunger. Second, as the packing is lubricated, both internally and externally, the friction and wear of plungers is reduced to a minimum. The first cost of this kind of packing is high, but the long life and easy running more than paid for the extra cost.

In looking over the packing stock about that time, I found several boxes of diagonal packing, Fig. 2, made for high-pressure steam having a hard round core and the usual wedges. It was the right size for another outside packed pump, and I decided, although it was bought for steam rods, to give it a trial in this place. It proved successful, although it did not last as long as packing used on the other pump for the reason that it was not designed for this class of work. The round section carries the weight of the plunger and the wedges sliding over each other prevent leakage.

Another packing, made especially for this service, is shown in Fig. 3. The pressure acts on the inner or concave side of the semi-circular sections pressing the lip out against the plunger. On the return stroke when the pressure is only that due to suction there is comparatively little friction on the plungers. In putting this packing into place, care must be taken to get the concave side next to the cylinder. Unless this is done the pressure cannot act on the thin lip to hold it against the plunger. The glands need to be drawn up only a little more than finger tight to prevent leakage, and the frictional load is low compared to square flax packing.

It has been my experience that the more turns of packing that can be placed in the stuffing-box the less pressure will be required on the gland to prevent leakage, or in other words, that a deep box is better than a shallow one.

Bad shoulders worn at each end of the stroke, which may be due to tight packing, hard packing or grit and sand working into it from the water are very hard on the packing, and with the plunger in this condition it would be necessary to increase the compression on the packing to prevent leakage. When the plungers become worn they should be put in a lathe and turned down. Then a brass bushing should be made to fit the plunger to about $^1/_{16}$ in. and make a neat fit in the bottom of the stuffing-box, to prevent the soft packing from working into the cylinder around the plunger. For an outside packed pump, I believe that, as a rule, although square flax packing is the lowest in first cost, a higher grade and more expensive packing will offset the low first cost through the reduction of the frictional or running cost to operate the pump, which goes on during the entire life of the packing.

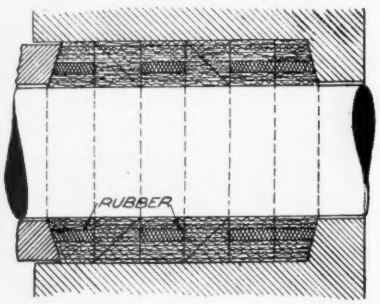


FIG. 1. HYDRAULIC CUSHION PACKING

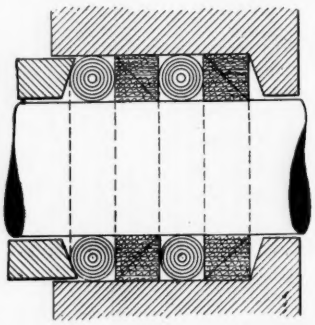


FIG. 2. RING AND CUSHION PACKING

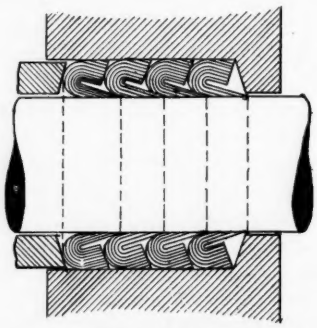


FIG. 3. FLEXIBLE LIP CUSHION PACKING

U. S. CIVIL SERVICE COMMISSION announces an examination for subinspector of construction. A considerable number of vacancies at various navy yards and other naval establishments of the United States, at entrance salaries ranging from $3.28 to $5.52 a day, will be filled from this examination. Competitors will be rated on education and experience, and must have reached their twentieth birthday on the date of filing application. Until further notice, owing to the lack of eligibles, the number of appointments to be made, and the urgent needs of the service, applications will be received at any time, and the papers will be rated immediately upon their receipt in order that appointments may be made with the least possible delay. Apply for Form 1312.

Belting*

PRACTICAL SOLUTIONS TO BELTING PROBLEMS INVOLVING THE TRANSMISSION OF POWER BETWEEN SHAFTS AT VARIOUS ANGLES

IN ORDER to transmit maximum power, it is essential that the arc of contact between the belt and pulleys be as great as possible. This condition is, however, ordinarily quite difficult to realize, due to short shaft centers, difference in diameter of driver and driven pulleys and sag of the belt, particularly when the driving side is on top. To increase the arc of contact under any one of the above conditions, so-called idlers are employed. These consist of comparatively small pulleys supported by separate hangers near the smaller working

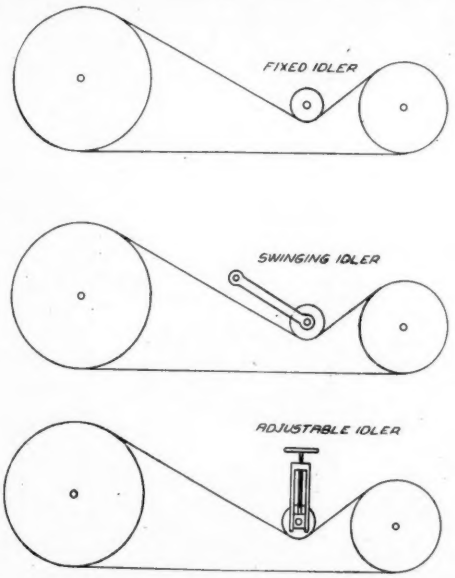


FIG. 13. METHODS OF EMPLOYING IDLERS TO INCREASE ARC OF CONTACT

pulley so as to increase the arc of contact of the belt at that point. Various methods of using idlers are illustrated in Fig. 13.

A particular form of idler is such as used in the Lenix system of drive, Fig. 14. This consists of a jockey pulley which rides on the loose side of the belt, on top, near the smaller pulley. It is carried on an arm that has a weight at the end so that it floats on the belt. The advantage is that with a large load, the belt is stretched to a greater degree and gives more slack which the floating pulley takes up as a partial wrap around the smaller pulley, thus overcoming the effect of centrifugal force. On short drives especially, this works well, 20 in. between the rims of wheels having been found ample for a drive and a belt ¼ as large as with the straight drive having been found sufficient. It is also possible to use a high ratio of diameters, as high as 30 to 1 having been successfully run.

QUARTER-TURN BELTS

REGARDLESS of the type of drive employed, a belt must always run squarely onto the pulley. When desiring to connect 2 horizontal shafts at right angles to each other, by a belt, as for example an engine shaft near the floor to a line shaft near the ceiling, a quarter-turn belt will be required. First ascertain the central point on the face of each pulley at the extremity of the horizontal diameter where the belt will leave the pulley and then set that point on the driven pulley plumb over the corresponding point on the driver. This will cause the belt to run squarely onto each pulley, and leave the pulleys at an angle greater or less according to the size of the pulleys and their distance apart.

In order that quarter-turn belts may remain on the pulleys, the central plane on each pulley must pass through the point of delivery of the other pulley. This arrangement does, however, not admit of reversed motion.

The general solution of the quarter-turn belt problem is shown in Fig. 15 where variation in the angles of the 2 shafts is illustrated.

USE OF LEADER PULLEYS

THERE IS no essential difference between a leader, or guide, pulley and one used for transmitting power, except that its strength need not be so great. Leader pulleys are used to direct a belt to the proper place on the main pulleys in drives so complicated that direct means can not be employed. Illustrations of their varied uses are shown in Figs. 15 to 19. The arrangement of 2 shafts so close together that a direct belt cannot be used is shown in Fig. 16, where it is necessary to employ 2 leader pulleys which are placed upon the same arbor or may be separated with axes at an angle with each other.

In some instances pulleys cannot be placed in the same plane upon parallel shafts, but must be offset as illustrated in Fig. 17-A. In this case, leader pulleys must be employed, these being placed upon a common arbor and run in the same direction, the diameter of the

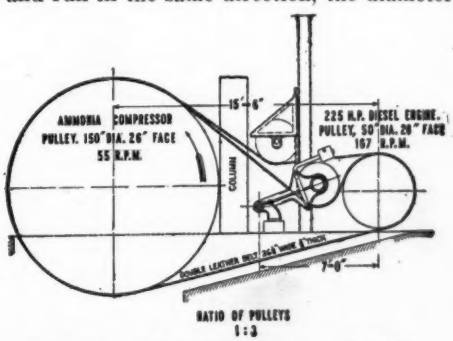

AMMONIA COMPRESSOR PULLEY. 150" DIA. 26" FACE 55 R.P.M.
225 H.P. DIESEL ENGINE. PULLEY. 50" DIA. 26" FACE 167 R.P.M.
15'-6"
COLUMN
7'-6"
RATIO OF PULLEYS 1:3

FIG. 14. THE LENIX SYSTEM OF DRIVE

leader pulleys being equal to the offset of the main pulleys.

The arrangement of 2 shafts in the same plane, but at an angle with each other, is shown in Fig. 17-B. In this case, also, 2 leader pulleys are necessary to secure best operation of the belts. A solution of the quarter-turn arrangement is that illustrated in Fig. 18-A, where but one leader pulley is used. This arrangement is usually more or less bothersome and the use of a leader pulley is advisable in a great many cases. Another

*Third and last article of the series, continued from page 345, April 15 issue.

solution of the same problem is shown in Fig. 18-B, where 2 leader pulleys are employed.

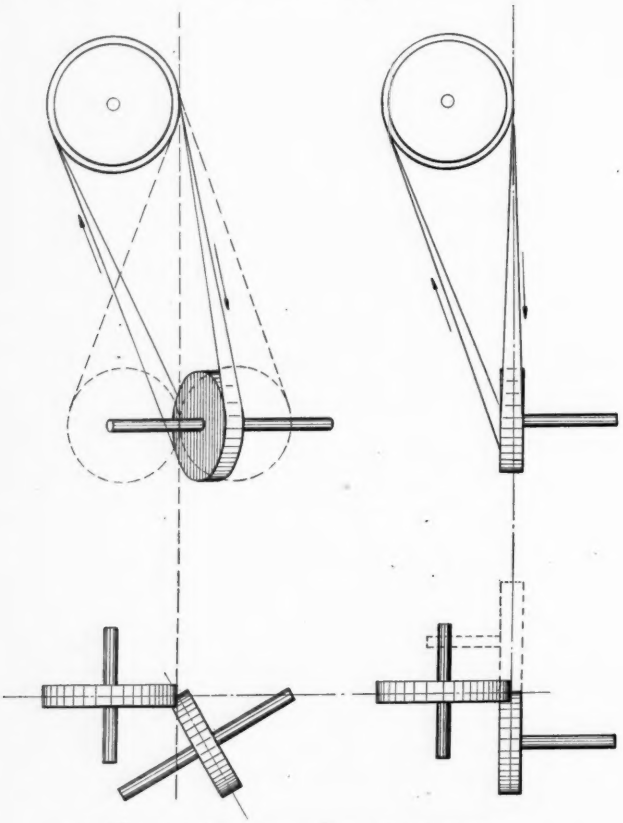


FIG. 15. QUARTER-TURN BELT ARRANGEMENT

It frequently occurs that by the use of a leader pulley which is adjustable in its position, the belt can be shifted from the loose to the tight pulley without the use of a belt shifter.

LOCATION OF PULLEYS

TO SECURE the best service from the belt and pulleys

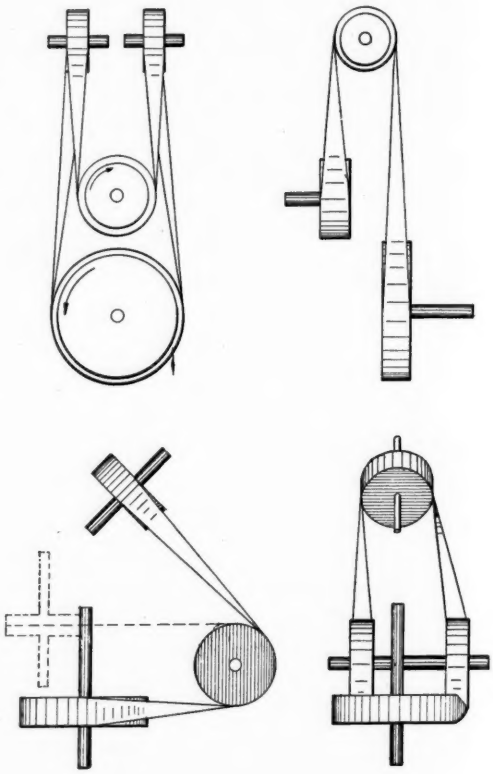


FIG. 16. COMMON USE OF LEADER PULLEY

and take advantage of the slack in the belt to give a greater arc of contact on the pulleys, they should be placed with their shafts parallel and in the same horizontal plane and the tight side of the belt at the bottom

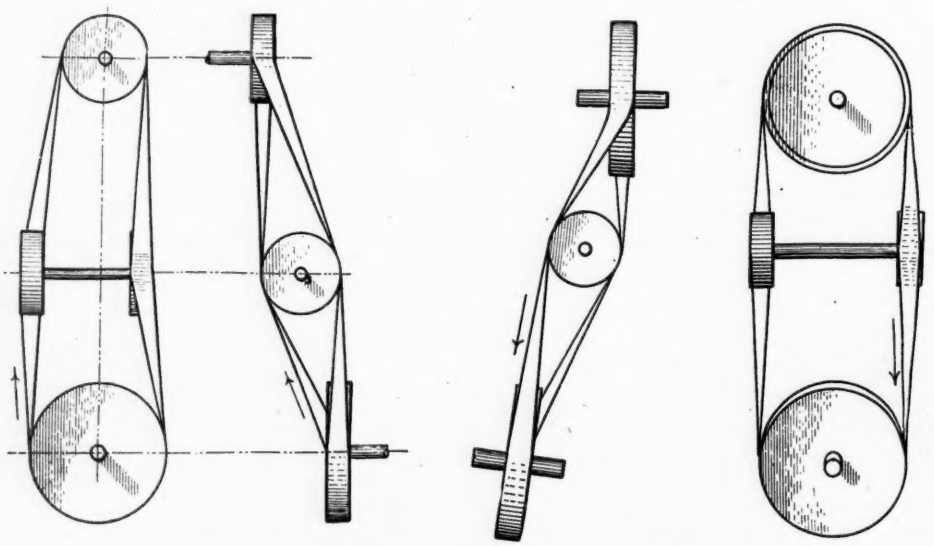


FIG. 17. (A) PULLEYS OFFSET; (B) TRANSMISSION BETWEEN SHAFTS AT AN ANGLE

This, however, is not always possible, and it is found necessary to run the belt at an angle from the horizontal, but vertical belts should never be employed where it is possible to run them otherwise. The difficulty here is that the belt must always have a belt tightener upon it, as any slack which may exist, causes the lower pulley to slip in the belt. To the difficulty arising from high tension of vertical belts may be added the trouble with an overpressure on the upper shaft bearings and the

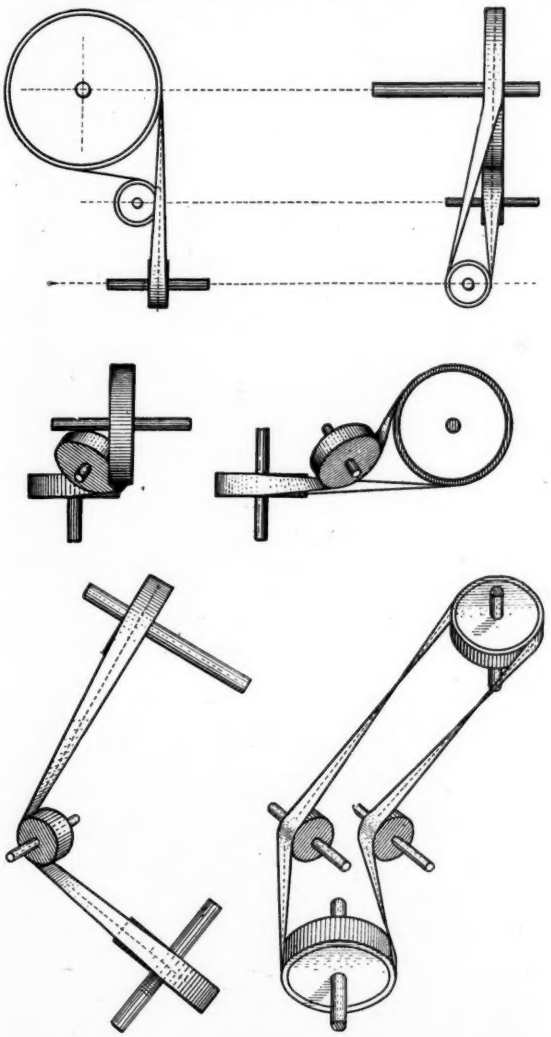


FIG. 18. (A) QUARTER-TURN ARRANGEMENT USING ONE LEADER PULLEY; (B) QUARTER-TURN ARRANGEMENT USING 2 LEADER PULLEYS

lifting of the lower shaft in such a way as to wear on the upper part of the lower bearings. These conditions are unnatural and should be avoided wherever possible.

A driven pulley located upon a long line shaft which has placed upon it several driving pulleys, should be located as near the center of the load as possible. In this way, it will be seen that the diameter of the shaft can be reduced considerably, as only half the power of the whole shaft is transmitted in each direction, and also the vibration, which is likely to occur in long lines of shafting.

SELECTION OF BELTING

WHERE REQUIRED to carry heavy loads, belting made from center stock leather should be employed; for general light or countershaft work, side stock or even shoulder stock belting will often meet the requirements satisfactorily.

In general it is found that rawhide, semi-rawhide and chrome-tanned belts are not as serviceable in dry places as oak-tanned belts. Rawhide and chrome-tanned belts give good service, however, in damp places such as breweries, laundries, dye-houses, etc.

According to the Mechanical Engineer's Handbook, commercial sizes of leather belting as adopted by the Leather Belting Association, range from ½ to 72 in. in width, the width increasing by ⅛ in. up to 1 in., by ¼ in. up to 4 in., then by ½ in. to 7 in., and above that by inches.

Some of the advantages claimed for rubber belts over leather belts are uniformity in width and thickness, durability when exposed to steam and dampness, great tensile strength and grip on the pulley. Rubber belts are also cheaper than leather or other belts suitable for

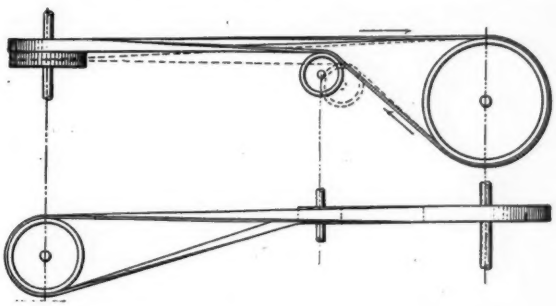


FIG. 19. LEADER PULLEY USED AS BELT SHIFTER

the same kind of work and are particularly serviceable in damp places or under unusual temperature conditions.

Commercial sizes of rubber belts run from 1 in. to 60 in., increasing by ¼ in. up to 2 in., by ½ in. up to 4 in. and then by inches.

Seven Days in the Coal Pile

THE CAT in the flywheel, told about in the March 1 issue, has nothing on the cat in the coal bin. I brought a young kitten into the boiler room as a mascot for the crew, but she was very wild and nervous and would run into the coal bin and hide whenever anybody came near.

On Wednesday, Feb. 21, at 10 a. m., when she was last seen before her adventure, coal was being dumped into the bin. Eleven tons were put in on that day and 26 tons the next day. Not seeing anything of "Moike," we concluded she was buried up in the coal.

Imagine our surprise when on Wednesday, Feb. 28, 6 p. m., we heard a very faint meow under the coal. We all got busy and after removing about 7 tons of coal from over the "meow," dug poor little Moike from her coal tomb. She was about all in—eight of her lives gone, weak as a kitten, etc. A pint of milk, some lovings, and one night's rest in a nice soft bed of waste and Moike was on the job again. P. J. CULLITAN.

Relation of Slag to Rust Resistance of Wrought Iron

THAT the reason for the rust resistance of genuine old-fashioned wrought iron appears to many to be shrouded in uncertainty is probably due to the expectation of finding it deeply buried in a maze of metallurgical mysteries. Such, however, is not the case, as the following facts will show.

Genuine wrought iron, as shown in the photomicrograph of an end section of pipe, Fig. 1, contributed by A. M. Byers Co., Pittsburgh, Pa., is composed mainly of iron and slag, the slag appearing black or dark gray and the iron light gray. It is to this slag, which is non-corrosive and electrically almost inert, that genuine

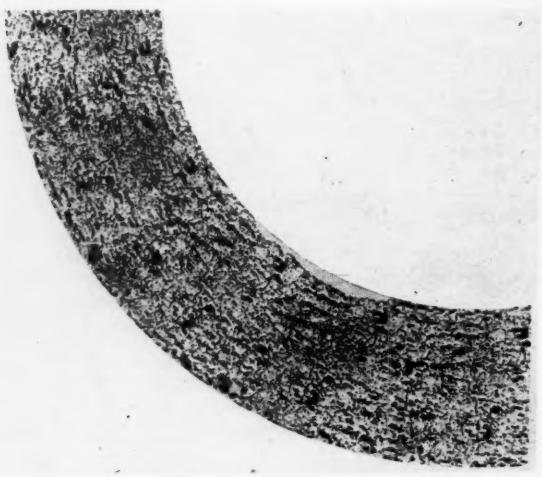


FIG. 1. VIEW OF END SECTION OF GENUINE WROUGHT IRON PIPE, HIGHLY MAGNIFIED, SHOWING ENDS OF SLAG BANDS EVENLY DISTRIBUTED THROUGHOUT THE METAL

wrought iron owes its resistance to corrosion, as rust can only destroy the iron, not the slag. Allowing for the magnification, a little calculation will establish that there are over a quarter of a million slag bands to the square inch, making it easy to understand why they offer such an effective barrier to the entrance of moisture and oxygen, the two most potent factors promoting corrosion.

The protection afforded by the slag contents of genuine wrought iron, about 6 per cent by volume, has its counterpart in the graphite flakes (see Fig. 3) found in pig iron; pig iron rusts very little. The slag and graphite respectively protect the underlying iron from corrosion, just as surely as does a surface coating of paint or galvanizing, only to an even greater extent. As soon as one slag barrier is penetrated, another is almost immediately encountered, with the result that an increasing number of successive barriers gradually combine more and more effectively to keep out corrosive agents.

The rusted area indicated by the cross lines in Fig. 1 represents the starting of a pit. A glance will show how the individual slag streaks at this point form an almost unbroken barrier with no opening actually larger than 0.001 in. This illustrates why genuine wrought iron tends to rust evenly all over, for the corrosion, proceeding along the lines of least resistance, tends to spread out instead of going deeper. Without the slag, nothing could retard or stop the pit, which would soon go straight through the pipe and cause an untimely leak.

The scientifically inclined reader, however, is liable to interpose the objection that there are large open

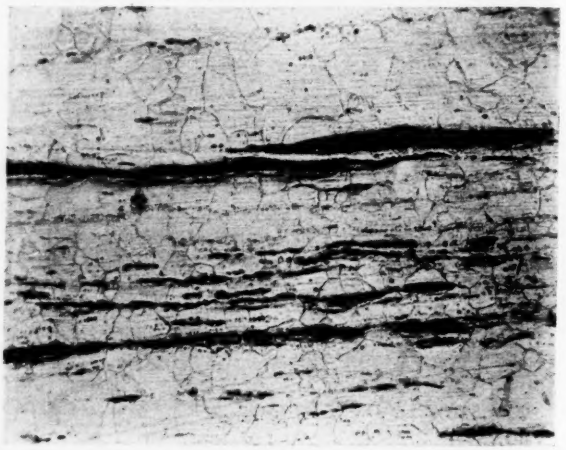


FIG. 2. VIEW OF LONGITUDINAL SECTION OF GENUINE WROUGHT IRON, HIGHLY MAGNIFIED. DARK PORTIONS ARE SLAG BANDS

spaces between the individual slag streaks. True there are open spaces, but most of them are considerably smaller than 0 001 in., infinitely smaller than the smallest pinhole. In comparison, we might say that nobody doubts that a window screen interferes to a considerable extent with ventilation and keeps out rain. Imagine one or two dozen screens laid on top of each other

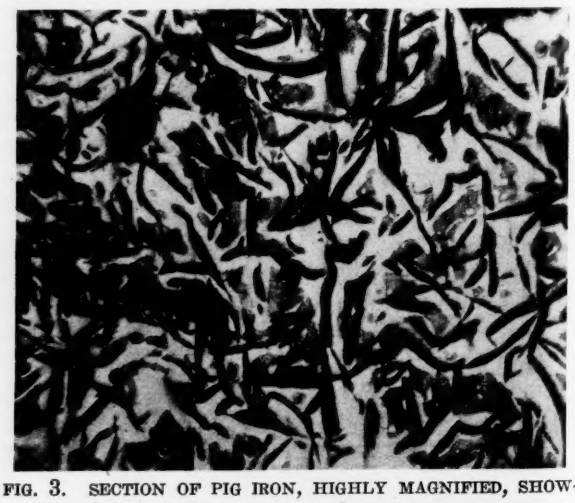


FIG. 3. SECTION OF PIG IRON, HIGHLY MAGNIFIED, SHOWING CRYSTALLINE STRUCTURE WHICH IS PROTECTED FROM CORROSION BY GRAPHITE FLAKES

irregularly with the wires intersecting in all directions, and that each screen is twice as fine as the finest screen made, or from 20 to 40 times finer than an ordinary window screen. The protection afforded by such an assemblage of screens would much resemble that of the slag in wrought iron.

Combustion of Bituminous Coals*

ADMITTING AIR THROUGH HOLES IN FIRES; STUDY OF GAS COMPOSITION AS AFFECTED BY FIRING METHODS. BY HENRY KREISINGER

THE main objection to introducing air over the fire by admitting it through holes in the fuel bed is that the amount of air thus introduced into the furnace can not be regulated suitably. The holes in the fuel bed are small immediately after firing and grow larger as the coal burns out; thus a small quantity of air is introduced when large volume of combustible rises from the fuel bed immediately after firing and when a large amount of air is needed. As the coal burns out and the holes become larger, more air is admitted into

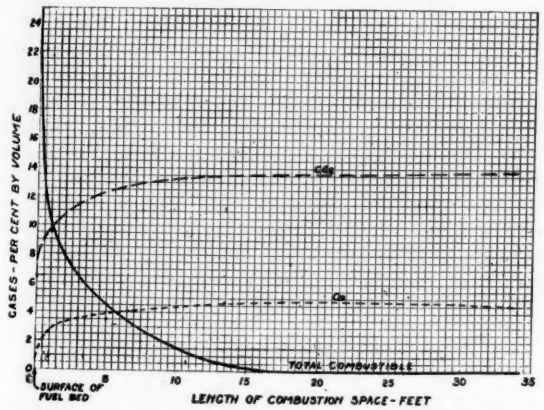


FIG. 5. CHARACTERISTIC CURVES SHOWING COMBUSTION PROCESS IN THE COMBUSTION SPACE OF A STOKER-FED FURNACE

the furnace. At the same time the volume of the combustible rising from the fuel bed becomes smaller, and therefore less air is needed to complete the combustion, so that the quantity of air flowing into the furnace through the holes is far too large; thus when air is introduced through holes in the fuel bed, there is incomplete combustion due to insufficient amount of air at one time, and entirely too much air shortly after that.

After a sufficient quantity of air has been added to and mixed with the combustible rising from the fuel bed, the mixture is burned in the combustion space. Figure 5 is a characteristic curve of the process in the combustion space of a stoker-fed furnace. The percentages of the various constituents of the furnace gases are plotted as ordinates and the length of combustion space as abscissae. The figure shows that at the surface of the fuel bed there is about 25 per cent of combustible gas besides some tar and soot which can not be expressed in percentage by volume. Air is added and mixed with these gases and as the mixture flows through the combustion space the percentage of combustible decreases at first very rapidly, but as the mixture flows farther from the fuel bed this decrease becomes slower and slower. The percentage of CO_2 increases from 6 to about 12 per cent, showing that the decrease in the percentage of combustible gas is due to combustion.

*Continued from page 349, April 15 issue.

The shape of the curve representing the percentage of combustible changes somewhat with the rate of combustion and the amount of air that is supplied over the fuel bed. With higher rates of combustion the curve is less steep and the gases travel farther away from the fuel bed before they are nearly completely burned. This is because with higher rate of combustion the combustion space can not burn the gases as fast as they are produced in the fuel bed, and they pass through larger volume of combustion space before they are completely burned. In other words, for higher rates of combustion, larger combustion space is needed to obtain nearly complete combustion.

When small quantity of air is supplied over the fuel bed the combustion is slower because of the rarefied oxygen. The gases therefore needed larger combustion space to burn nearly completely. The effect of rate of combustion and the amount of air supply on the size of combustion space required for a given degree of completeness of combustion is shown in Fig. 6. This shows 6 groups of curves, each group being a separate chart, indicating the relation between the rate of combustion and the length of combustion space required for a given completeness of combustion and a given coal. The upper 3 groups of curves give this relation for Pocahontas, Pittsburgh and Illinois coal for combustion complete to 95 per cent. The lower 3 groups give the relation for the same 3 coals but for combustion complete to 98 per cent. Each curve of each group represents the above relation for one amount of air supply expressed in percentage of the excess above the quantity theoretically

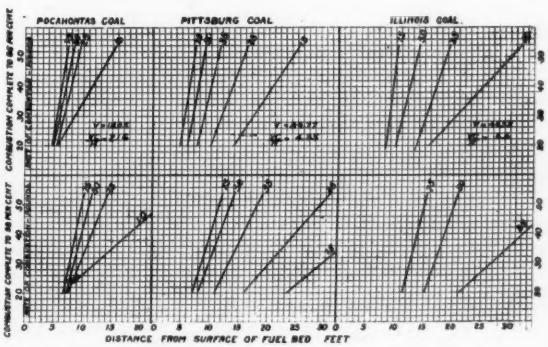

POCAHONTAS COAL
PITTSBURG COAL
ILLINOIS COAL
COMBUSTION COMPLETE TO 95 PER CENT
COMBUSTION COMPLETE TO 98 PER CENT
DISTANCE FROM SURFACE OF FUEL BED FEET

FIG. 6. EFFECT OF RATE OF FIRING AND EXCESS AIR ON THE SIZE OF COMBUSTION SPACE REQUIRED FOR A GIVEN COMPLETENESS OF COMBUSTION. FIGURES AFTER V GIVE PERCENTAGE OF VOLATILE MATTER IN DRY COAL; FIGURES AFTER $\frac{VC}{H}$ GIVE RATIO OF VOLATILE CARBON TO AVAILABLE HYDROGEN

needed for complete combustion. This percentage is indicated by the figures at the upper end of each curve. The curves show that with any given coal and any excess

of air larger combustion space is needed as the rate of combustion increases; and also the combustion space must be increased when the air supply is decreased. Although the relation, as shown, holds true strictly for furnaces equipped with Murphy stoker, it can be applied to other stoker-fed furnaces with reasonable accuracy.

Effect of Firing Cycle on Composition of Gases

In hand-fired furnaces the conditions of combustion are different. The intermittent feeding of coal makes the processes of combustion in the space of the furnace more complicated. Immediately after the firing, while the volatile matter is being distilled, there is a large percentage of combustible gases with very low percentage of free oxygen to burn it. Before firing, when there is no distillation taking place, the furnace gases contain small percentage of combustible gases and large percentage of oxygen. In other words, during 30 sec. immediately after firing, the air may be supplied at the rate of only 10 lb. per pound of coal, whereas during 30 sec. before firing the air may be supplied in quantity of 18 lb. to a pound of coal. This effect of firing cycle on the process of combustion is shown in Figs. 7 and 8. Figure

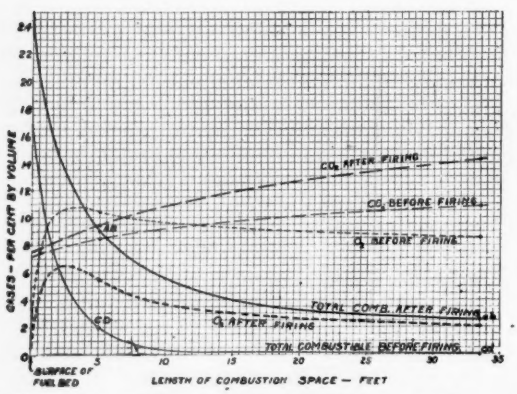


FIG. 7. CHARACTERISTIC CURVES OF THE PROCESS OF COMBUSTION IN THE COMBUSTION SPACE OF A HAND-FIRED FURNACE

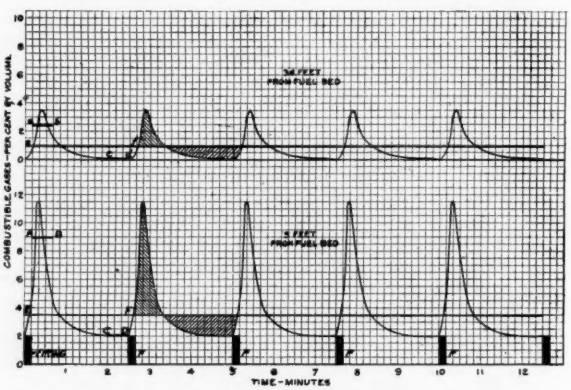


FIG. 8. VARIATION OF PERCENTAGE OF COMBUSTIBLE GASES CAUSED BY INTERMITTENT FIRING IN A HAND-FIRED FURNACE

7 is similar to Fig. 5 and contains two sets of curves compiled from data of tests made with the same experimental furnace, but equipped with hand-fired grate. The heavy curves represent the composition of gases along the combustion space during 30 sec. immediately after firing, and the light curves the composition during 30 sec. immediately before firing.

The difference in the percentage of combustible gases before and after firing is shown even more strikingly in Fig. 8. The two saw-tooth curves show the variation of the percentage of combustible gases due to intermittent firing; the upper curve showing this variation at a section 34 ft. from the fuel bed, and the lower one at a section 5 ft. from the fuel bed. The firing intervals are indicated at the foot of the chart by the shaded rectangles.

In Fig. 8, lines AB and ab represent the average percentage of combustible gases during 30 sec. after firing, and lines CD and cd, the average percentage of the combustible gases during 30 sec. before firing. Lines EF and ef represent the average percentage of combustible gases during an entire firing cycle. Each average represents 4 to 6 samples collected simultaneously during 10 firing cycles, so that the data are fairly representative of the actual condition existing in the furnace.

Effect of Rapid Heating on Rate of Distillation

The difference in the percentage of combustible gases before and after firing is due to distillation of the volatile matter from the coal during a short period, immediately after firing. This difference is the greater the more rapid the distillation. The rapidity of distillation greatly increases with the rate of heating of the freshly fired coal. For good results the rate of heating should be as low as possible in order that the distillation may be slow and spread over a long period, so that sufficient quantity of air can be added to and mixed with the volatile matter and the mixture given time to burn in the combustion space.

In some cases the rate of heating of the freshly fired coal is made higher than necessary by placing fire brick arches over the grate. These arches heat the coal by radiation and partly by reflection of radiant heat from other hot objects in the furnace. Figure 9 shows the right place and the wrong place for fire brick arches under horizontal-tubular boiler and also the right way and the wrong way to make a furnace roof under a water-tube boiler. The upper picture of the return-tubular boiler shows the arch placed over the grate, which is a wrong position for it, because it heats the coal too rapidly; the lower picture of the horizontal-tubular boiler shows the arch in the right place. The arch in this case does not heat the coal but keeps the gases hot after they have left the fuel bed and passed beyond the bridgewall. It also helps in mixing the gases with the air much better than the arch placed over the fuel bed. The exposed boiler shell over the grate does not cool the gases enough to affect their combustion appreciably, because the gases do not come in contact with the shell to any great extent, but pass under the shell into the space beyond the bridgewall. The upper picture of the water-tube boiler shows a furnace roof made of C-tiles, completely enclosing the tubes of the boiler. When these tiles become hot they increase the

rate of heating of the freshly fired coal and cause rapid distillation. The lower picture shows the part of the roof over the grate made of T-tiles, and the part beyond the bridgewall of C-tiles. Thus the tubes over the grate are exposed and tend to lower the rate of heating of the coal, while beyond the bridgewall the C-tiles keep the gases hot and help in their combustion.

The effect of rapid heating on the distillation of the volatile matter is shown in Fig. 8. The figure is compiled from results of tests made with a hand-fired furnace having a fire brick arch over the grate. The curves show a very rapid distillation for a short period after firing.

Composition of Combustible Gases in Furnaces

The combustible gases in the boiler furnace consist mostly of CO, a small amount of H_2 and only a trace of CH_4. The visible luminous combustible is chiefly soot. Under ordinary conditions of operation of power plant boilers there are practically no tars 2 or 3 ft. from the fuel bed. The relative proportions of the different gases

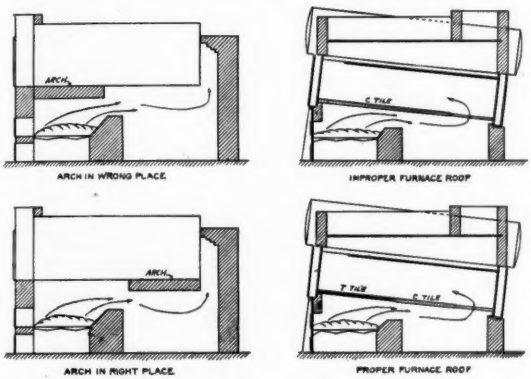


FIG. 9. TWO METHODS OF MAKING FURNACE ARCHES AND FURNACE ROOFS

in boiler furnace are shown in Fig. 10. This figure, which has been compiled from several hundred analyses of gas samples collected at different places in a furnace, shows that 4/5 of the gases consist of CO and the remaining 1/5 is nearly all hydrogen. Hydrocarbon gases do not appear in measurable quantity. As a matter of fact, hydrocarbons can not exist at the high furnace temperatures; they are decomposed rapidly into soot and hydrogen. Methane (CH_4), which is the most stable hydrocarbon, is found only in small traces 5 ft. from the fuel bed. Although the volatile matter leaves the coal almost entirely in the form of tars, which are heavy hydrocarbons, these tars are almost entirely decomposed into light gases and soot before they pass 2 ft. from the fuel bed. This means that the black smoke which consists almost entirely of soot is formed within 2 ft. of the fuel bed, and not by the gases striking cold surfaces of the boiler.

It may seem that since CO persists the longest in the furnace, it is the most difficult gas to burn; however, such is not the case. CO is a simple gas which burns very easily in the rarefied oxygen of the furnace atmosphere. It persists in the furnace because it is constantly formed by the reduction of CO_2 coming in contact with the hot particles of carbon or soot in the luminous flames. On account of the high concentration of the CO_2 in the furnace gases the soot burns with CO_2 to CO and then the CO burns with the comparatively rarefied oxygen to CO_2. The combustion of the soot with CO_2 is the quicker the higher the furnace temperature. This is the reason why the soot or smoke can be burned more quickly in a combustion space enclosed by hot fire brick.

CO_2 as an Indicator of Excess Air

As excess air is an important factor in the combustion of coal, it may be desirable to give a simple curve

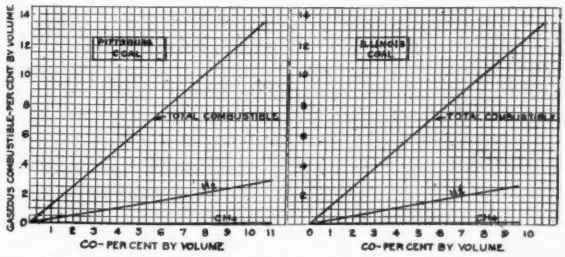


FIG. 10. RELATION BETWEEN CO AND OTHER COMBUSTIBLE GASES

for obtaining the excess of air when the percentage of CO_2 in the furnace gases is known.

Figure 11 gives such relation between the percentage of CO_2 in the furnace gases and the percentage of excess air for Pocahontas and Illinois coals. The curves were determined by plotting the results of a large number of tests made with the two coals and burned with different percentages of the excess of air. Most of the steaming coals, as far as their chemical composition and burning qualities are concerned, fall between these two coals, so that points for any other coals can be located with fair accuracy in the space between the two curves. The few

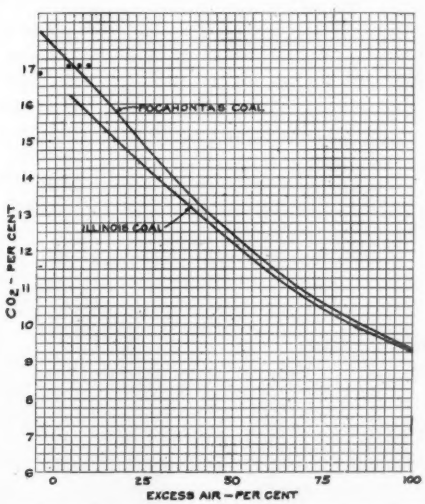


FIG. 11. RELATION BETWEEN CO_2 AND THE PERCENTAGE OF EXCESS AIR

points at the upper end of the Pocahontas coal curve are intended to show that when the excess of air is brought close to zero the combustion becomes less complete and the points fall away from the curve. When the excess of air is above 20 per cent the points fall on the curve. The curves show that the maximum CO_2 that can be obtained with the Pocahontas coal is about 1½ per cent higher than the maximum CO_2 that can be obtained with the Illinois coal.

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

Generator Control---IV

SYNCHRONIZING AND SYNCHRONIZING EQUIPMENT

WHEN parallel operation of alternating-current generators is desired, greater precautions must be exercised than in the case of direct-current machines. Due to the very fact that the electromotive forces of such machines alternate through positive and negative values rapidly many times each second, it is necessary not only that the voltage of the incoming machine be equal to that of the bus bars but that the number of alternations per second, or frequencies, should be of like value and the machines must be "in phase"; that is, all corresponding points on the electromotive force curves of the various machines so connected, must coincide.

Phase relations may be determined by synchronizing lamps or synchronism indicators; due to their greater degree of accuracy and reliability, the latter are, however, more generally employed.

In Fig. 22 are shown two single-phase machines, A and B feeding a pair of bus bars through switches S' and S. Connected to the machine leads are two transformers, T' and T, the secondaries of which are connected in series with synchronizing lamps l' and l, and switch SS. With the machines in synchronism, as they must be when operating in parallel, the direction of current flow from A and B through the primaries of transformers T' and T respectively is indicated by the directions of the arrows. In each case this flow of primary current is from left to right; that in the secondary windings we know from the theory of the transformer is at any instant in a direction opposite to that in the primaries or, in this case, from right to left. Consequently the electromotive forces induced in the secondary windings of these transformers oppose or neutralize each other and the lamps remain dark. It is, therefore, apparent that with the connections shown the only time to throw machines A and B in parallel is after their respective voltages are of like value and the synchronizing lamps are dark.

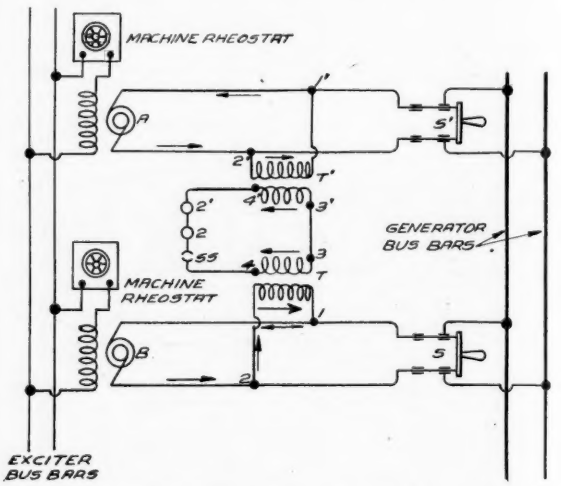


FIG. 22. DIAGRAM OF CONNECTIONS OF SYNCHRONIZING TRANSFORMERS, LAMPS AND SWITCHES AS USED WITH 2 SINGLE-PHASE GENERATORS

If, however, it is desirable to indicate complete synchronism with the lamps up to full candlepower, reverse the secondaries of either transformer.

Due to the fixed relation existing between the various phases of polyphase machines it is necessary to

FIG. 24. WESTINGHOUSE TYPE SI SYNCHRONOSCOPE

FIG. 25. GENERAL ELECTRIC SYNCHRONISM INDICATOR

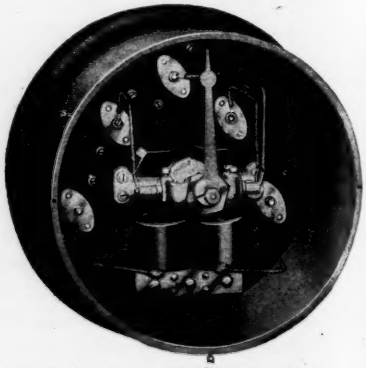


FIG. 26. INTERNAL VIEW GENERAL ELECTRIC SYNCHRONISM INDICATOR

synchronize only one of the phases. Synchronizing equipment connections for an installation of 3 3-phase machines are shown in Fig. 23.

Whether lamps shall be "light" or "dark" for complete synchronism may be readily determined by means of the following procedure. In the case of a 2-machine installation, raise the brushes on one of them, throw in the main switches and note whether the lamps are "light" or "dark." If dark, the machines are to be thrown in parallel with the lamps cut; if lighted, complete synchronism is to be recognized by this condition. A similar procedure is easily arranged for machines with stationary armatures by disconnecting the proper leads.

Synchronism Indicators

Synchronism indicators or synchronoscopes are generally preferred to synchronizing lamps as they indicate more exactly the difference in phase angle at every instant and the difference in frequency between the incoming machine and that of the system to which this machine is to be connected.

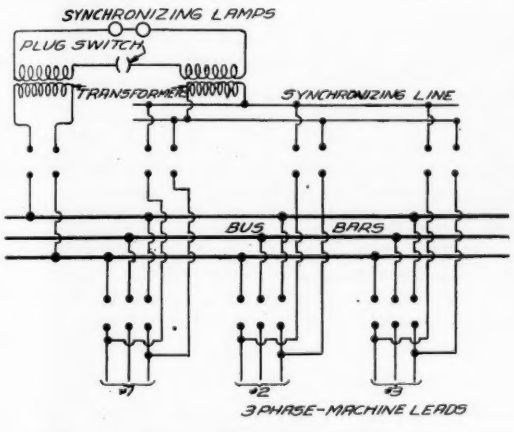


FIG. 23. SYNCHRONIZING EQUIPMENT CONNECTIONS FOR AN INSTALLATION OF 3 3-PHASE GENERATORS

In the synchronoscope, built by the Westinghouse Electric and Manufacturing Co., a rotating field is produced by current from the bus bars passing through a split-phase winding and 2 angularly placed coils. In this rotating field is a revolvable iron vane, or armature, magnetized by a stationary coil connected across the lines of the incoming generator. As the armature is attracted or repelled by the rotating field of the coils connected to the bus bars, it assumes that position at which the zero of the rotating field occurs at the same instant as the zero of its own field. Thus its position at every instant indicates the phase angle between the voltage of the incoming machine and that of the bus bars. As this angle changes, due to difference in frequency the iron vane or armature with the attached pointer rotates, and when synchronism is reached it remains stationary.

The synchronoscope of the General Electric Co. is in construction not unlike a small 2-phase bipolar synchronous motor with the field or stator supplied with alternating instead of direct current. Two coils placed at angles of approximately 90 deg. and supplied with current from the incoming machines through the medium of collector rings constitute the armature windings; one of their coils is connected in series with a resistance while the other is connected in series with a reactance. Due to this arrangement generating a rotating field in the armature, while the stationary field is alternating, the armature tends to assume a stationary position where the fields coincide when the alternating field passes through its maximum value. Hence the armature and its attached pointer moves forward or backward at a rate corresponding to the difference of frequency, and the position when stationary, depends on the phase relation. When the machines are running at the same frequency and in phase, the pointer is stationary at the marked position.

In order to eliminate system disturbances and frequently disastrous results caused by errors in judgment on the part of operators as to the proper instant at which to throw in the switches of the incoming machine, automatic synchronizers have been devised. These instruments automatically complete the circuit operating the closing coils of electrically-operated switches or circuit breakers when conditions are proper for synchronizing. A relay switch is interposed between the synchronism contacts and the main switch.

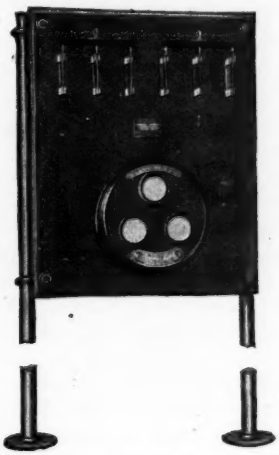


FIG. 27. GENERAL ELECTRIC GLOWER TYPE SYNCHRONISM INDICATOR

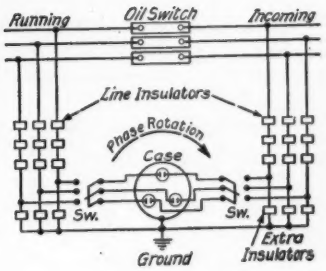


FIG. 28. DIAGRAM OF CONNECTIONS OF GENERAL ELECTRIC ELECTROSTATIC SYNCHRONISM INDICATOR

According to information furnished by the Westinghouse Electric & M'f'g Co., the features of the automatic synchronizer built by that company are as follows: The instrument has two solenoids the cores of which are attached at the upper ends to either end of a lever swung centrally on a shaft. Attached to the shaft is a suitable contact arrangement which is normally open. When the machines reach the proper relation of frequency and voltage, the contact device closes and completes the circuit through the closing coil of the main switch, the current for actuating this switch being taken from a source independent of the main generators such as an exciter. Current for energizing the solenoids is derived from the bus bars and from the incoming machine through transformers. The secondary voltage of these transformers is nominally 100 v., so that the synchronizer may be placed on a control board without danger to attendants.

A control switch is used for tripping the main switch when desired, but the main switch can be closed only

by the circuit through the synchronizer. A relay inserted in the closing coil circuit holds the circuit open until the proper moment for synchronizing, when the synchronizer operates the relay and completes the circuit.

Glower-Type Synchronism Indicators

While synchronism indicators of this type do not, strictly speaking, belong to the subject under discussion, their functions being practically identical to the instrument just described, mention of them will not be out of place. For synchronizing low-voltage machines or high-voltage machines in connection with which transformers are required for indicating or measuring purposes, lamps or electro magnetic indicators find their greatest field of adaptability. But when desired to connect together systems in which transformers are not required for indicating and measuring instruments, the equipment is comparatively expensive and the higher the voltage the greater is such expense. With electrostatic synchronizers, however, no transformers are required as they operate entirely on the charging current of the line insulators.

An indicator of the type for 2-phase service is shown in Fig. 27, mounted with 2 3-phase disconnecting switches on a regular switchboard panel. The synchronizer proper consists of a case containing 3 electrostatic glowers connected to the lines to be synchronized through the medium of the disconnecting switches and strain or suspension-type insulators. As will be noted, the terminals of one of the glowers are connected to the same phase of running and incoming lines while the terminals of the other two glowers are each connected to dissimilar phases.

With the incoming machine up to proper speed and voltage and ready to be synchronized, the disconnecting switches are thrown in at once, causing the glower elements to flicker in a manner not unlike that of the ordinary synchronizing lamps; the apparent direction of rotation indicates the relative speeds of the incoming and the running machines. When these machines are, however, in exact synchronism, the rotation will stop and the upper glower, Fig. 28, that one, the terminals of which are connected to the same phase, will be dark, while the others will remain lighted, but at about one-half brilliancy.

Drying Out a Power Plant

Method of Restoring Machinery to Working Conditions After a Flood. By R. A. Cultra

WE were just congratulating ourselves on our good luck in keeping the station in continuous operation throughout the winter without the usual interruption of service due to anchor ice and other troubles so prevalent in the operation of a hydro-electric plant. But Old Sol peeped over the distant hills and with a vengeance started his annual destruction of the winter's snowfall and whenever he did hide his face behind dark clouds, the waters from the heavens would descend in torrents, all adding to the anxiety of the station operator who alone knows what this means to a water power plant. Our greatest fears were realized and the wheel pits and generator room soon were knee-deep in water. To add to the "joys," the accompanying storm had swept down all of those transmission line poles which had not been washed out and, as a result, not a wheel could be turned; even if it had been possible to do so, it would have been of no avail, as no means were at hand to transmit any energy which might have been generated.

After what appeared to be a month's time, but which in reality was a few days, the water receded to its normal level and revealed a sight not pleasant to look upon. The generator room was one mass of mud, sticks, chips, leaves and all manner of litter, and of greater moment were the water soaked generators. Machines and other equipment were cleaned as well as could be, stoves placed about the room and a temperature carried therein which was far from comfortable.

In order to clean the generators they were practically stripped of brush holders and brushes insulating bushings and washers, and in the case of 2 of the alternators the entire field coils were removed and piled up around the stove for several days to allow them to dry thoroughly, during which time their armatures were kept revolving, and by the circulation of the warm air were soon dried.

While this process of drying was satisfactory to some extent, it was not of such thoroughness that we were satisfied to put the machines onto the line after being assembled. Instead, they were connected up as formerly and put into operation, but at about half their rated voltage, and maintained at this for a number of days so as to remove the last trace of moisture.

During the time we were having our troubles at the plant, an extra crew of linemen was employed to straighten out the transmission line, and at the end of 2 weeks we were again serving our customers with the usual reliable service.

What is reported to be the largest smokestack in the world is to be built for the Anaconda Copper Mining Co., at Anaconda, Mont. It will be 60 ft. in diameter on the inside and from its base to the top will measure just 525 ft. In connection with the big stack will be a smoke treater, or series of treaters, which will take out and recover all of the copper values from the smoke, catch all of the suspended dust particles and most of the arsenic in the smoke.

In the construction of the stack there will be required 10,000,000 bricks. The construction will require a year and perhaps a little longer before the new improvement will be ready for use.

There is a stack in Japan that is a little more than 600 ft. high, and in Tacoma there is one in course of construction that is just a few feet higher than that of the Anaconda Copper Mining Co. Neither of these, however, have anything like the diameter, or handle anywhere near the gas volume of this one.

Agency for sale of gas and gasoline motors and engines is desired by a commission merchant in Spain. Quotations should be made c.i.f. destination or f.o.b. New York, and payment will be made through a local or New York bank. Correspondence may be in English, and further information may be obtained from the Bureau of Foreign and Domestic Commerce, Washington, D. C., or any of its district offices, by inquiring about No. 24,169.

Power Equipment for Laundry

By T. W. Reynolds

THE laying out of laundry equipment with a satisfactory solution of its power requirements affords an interesting study. One who attempts to solve such a problem will find himself seriously handicapped through the lack of sufficient published data bearing upon the subject. A laundry handling 175,000 pieces a week will have about 23 washers, each approximately 36 by 54 in. in size, working 56 hr. a week. This means about 135 pieces of laundry per hour per washer. Each washer is filled about half full of water for the washing process, which is carried out on the following schedule:

Wash	Temperature	Time of Run, Min.
Cold rinse	Room temperature	5
First suds	Brought to boiling in 10-15 min.	25
Second suds and bleach	Brought to boiling in 10-15 min.	25
Warm rinse	140°-180°	5-10
Warm rinse	140°-180°	5-10
Warm rinse and acid	105°	5-10
Blue	105°	5-10
Rinse	105°	5-10
Rinse	105°	5-10
		85-115

Using the preceding schedule and figures, one can approximate pretty well what the hot water demand will be, after finding out about how much "wash" per week the laundry will have. Probably some of the steps in the schedule will be omitted on account of the class of work handled by the particular laundry under consideration; for instance, in an asylum laundry there is no necessity for the entire method of procedure as above.

The accompanying schedule and figures have been taken from an actual installation in which only 9 of the washers previously mentioned are run from a jack shaft by 2 20-hp. motors. The shaft is split in the middle, so that only 4 washers are on one motor, and 5 on the other, but if one motor gives out, the 2 shafts can be coupled together by a friction clutch.

The "wash" from these 9 washers is dried by 4 extractors, each having a 5-hp. motor.

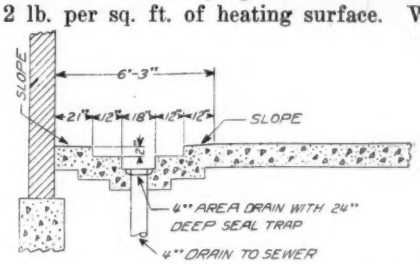
The dried "wash" is then separated by tumblers, 2 tumblers serving these 9 washers. Each tumbler has a separate 2-hp. motor.

Each mangle should have a 3 or 5-hp. motor, depending upon its size. If several mangles are run off one shaft, a saving in motor installation can be made, as they will not all be starting at the same time, and perhaps not all running at the same time.

Each electric hand iron takes 5 amp. at 220 v. This includes the current taken by a 25-watt pilot light, with which each iron should be provided. Some difficulties will be had in the use of electric irons, on account of the heating elements burning out; however, there is no satisfactory substitute—gas may often be too expensive. In an asylum laundry, doubtless but a few hand irons would be all that would be required in any event.

Mangles and ironing machines of all kinds should be heated by steam or gas. If by steam, 80 to 100 lb. is needed. If gas is used, it is necessary to parallel the gas lines by a compressed air line, as all the gas-heated machines have Bunsen burners. From tests, it has been found that steam-heated machines on an average condense 2 lb. of steam per hour per square foot of useful ironing surface. This figure is ample to cover losses in the body of the machines, and these losses, as a rule, are large enough to make heating of the rooms by direct radiation unnecessary. Of course, the condensation will vary slightly with changes in the outside temperature. When woolen blankets are put through the mangles without any previous drying, the condensation is as high as 4 lb. per sq. ft. of ironing surface. As a rule, blankets and flannels of all kinds that are likely to hold considerable moisture are put into a tumbler-drier after being washed. This tumbler-drier is similar in its action to an ordinary tumbler, but has heating coils in the base.

Each drying room or drying machine (like the tumbler-drier) should have a separate motor-driven fan to provide circulation of air. This fan should be mounted on top of the drier, and discharge outdoors. The condensation in the drying coils should not be over 1½ to 2 lb. per sq. ft. of heating surface. With the



CROSS SECTION OF DRAINAGE TROUGH

driers furnished by the manufacturers of laundry machinery, it is necessary to use live steam, as the heating surface is cut down to the limit. If you have plenty of exhaust steam available, this can be used for heating the driers; but the heating surface should be increased 25 to 50 per cent, depending upon the size of the drier, and a greater air circulation should be insured by using a larger fan than is usually called for by drier manufacturers.

In making the electrical layout, plenty of outlets should be left for marking machines and sewing machines. These are motor-driven and take about $^1/_{15}$ hp. Also, if possible, provide a trough in the floor that will carry away the water from the washers and extractors quickly. The water from the washers is dumped out all at once; that from the extractors is running out all of the time. A cross section of a typical concrete trough in a concrete floor is illustrated herewith. This should be run under the washers and extractors and pitched to the center or one end to a point convenient for drainage to sewer.

Why is the ocean blue? Because of the reflection of the sky? This accounts for some of the color, but it is largely a matter of saltness and density. In the tropics where the intense heat and rapid evaporation cause the water to be much saltier the blue is vivid, while the further one goes toward the poles the greener the hue becomes.—Popular Science Monthly.

Safety Precautions in Refrigerating Plants

New York City Provisions Against Fire Hazard, Explosion and Suffocation

TO safeguard against the starting of fires in a mixture of ammonia gas and air, the regulations require that in all "refrigerating machinery rooms," where compressors, generators, condensers, receivers, absorbers or other apparatus to produce or contain the refrigerating agent are located, and where ammonia or ethyl chloride are used, no arc lights, gas jets or other apparatus employing flame shall be used except internal combustion engines with internal ignition.

Rooms having only refrigerating coils and supply pipes are not so restricted.

Also, to prevent possible spread of fire, all refrigerating machinery rooms must be separated from other parts of the building by tight partitions and tight self-closing doors, and from boilers by tight fireproof walls having all openings closed by tight self-closing fireproof doors or stationary fireproof windows.

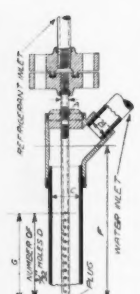
Gas Escape

WHEN FIRE has started, there is, of course, danger of explosion and of suffocation of firemen from liberated ammonia fumes due to leaking pipes. To overcome this, the rules provide that for all plants of 3 tons or over refrigerating capacity, using ammonia or ethyl chloride, connection must be made for emergency discharge of the refrigerant under pressure into sufficient water to absorb all gas and carry it off to the sewer. The absorption is done in an ejector mixer, constructed and connected as shown in the illustrations, Fig. 1 being the ejector, Fig. 2 the connection for a compression system, and Fig. 3 for an absorption system. Table I gives the sizes of connections.

Water is supplied through a Standard Fire Department Siamese Connection, which with the controlling valves for the emergency discharge, is located on the street side of the building, either outside the wall or in a vestibule having glass panel doors to give easy access. The valve box is to be not over 5 ft. above the street or floor and clear of any outlet for ventilating the refrigerating plant. The valves and water connection, which are for the sole use of the fire department, are to be protected by a suitable box, opened only by a department inner box key and legibly labeled "For Fire Department Use Only."

High and low pressure ammonia valves must be clearly labeled, and a notice posted in the box, "Do not open valves until water is flowing. Maintain 50 lb. pressure."

No valves are to be placed in the emergency lines other than the department control valves, except that one valve may be located on each line near the connection to the main high and low pressure lines, for repair purposes only; but such repair valves must be kept open at all times. In large plants, gages may be installed on emergency lines to determine changes in pressure when those lines are operating.



Tonnage	Safety Valve Inlet In.	Safety Valve Outlet In.	Diam. of each emergency valve or pipe, In.	Inches A	Inches B	Inches C	3/32" holes D	Inches E	Inches F	Inches G
24	½	1	½	1	1¼	5	266		50	15
56	¾	1¼	¾	1¼	2	6	460	See Note	60	20
102	1	1½	1	1½	2	7	625		70	25
166	1¼	2	1¼	2	2½	9	1000		90	30
240	1½	2½	1½	2	2½	9	1000		90	30
428	2	3	See note below				-		-	-

Note E: - The outlet from the ejector shall be four times the area of "B" wherever possible.

Where it is impossible to make the outlet four times the area of water inlet under standard conditions, a smaller size apparatus shall be used, adjusted to the possible size of the outlet.

For large plants use one additional mixer of maximum capacity for each additional 240 tons or fraction thereof.

Plants containing more than one unit shall be independently connected to mixer or mixers from each main suction and discharge line.

FIG. 1. WATER AND REFRIGERANT EMERGENCY MIXER

TABLE I. SIZES OF SAFETY VALVES AND EMERGENCY MIXER CONNECTIONS

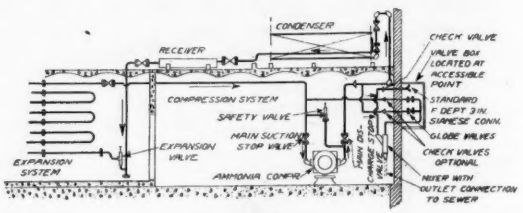


FIG. 2. EMERGENCY CONNECTIONS FOR COMPRESSION PLANT

For carbon dioxide plants, automatic safety valves may be placed on high and low pressure lines as a substitute for the emergency device, the location being as shown for connection of the emergency discharge lines, and the outlet discharging into the atmosphere.

Several copies of rules directing all employes as to duties in case of fire or other emergency, and satisfactory to the Fire Commissioner are to be posted about the plant, and employers are held responsible for proper drill of employes in such emergency duties.

Safety Valves

TO GUARD against overpressures, plants of over 3 tons capacity must have an automatic safety valve, of size shown in Table I, on each compressor or generator, to open at not over 300 lb. for ammonia, 1400 lb. for carbon dioxide, 100 lb. for sulphur dioxide or ethyl chloride. This valve is to be connected to the high pressure side, and may discharge to the low pressure side or through continuous piping to a point at least 10 ft. above the highest opening in the roof of the building, and as far as possible from horizontal openings in surrounding buildings. For ammonia, the end of an atmospheric discharge pipe must have a diffuser which will mix the gas with air without restricting its flow. Pressures named above are the maximum allowed to be carried in any plant for the various refrigerants named.

All pipes must stand a hydrostatic test to twice those maximum pressures, and all fittings must be guaranteed to stand three times those pressures. Gage glasses are

to be adequately protected and provided with shutoff valves.

Escape from Fumes

To protect from suffocation, all refrigerating machinery rooms must have adequate ventilation to the open air direct or by suitable ducts, the control of mechanical ventilation being located at an easily accessible point. Openings that permit passage of gases to parts of the building, not a part of the refrigerating plant, must be sealed or have tight self-closing doors. Refrigerating machinery rooms must have direct exit to open air or to a room or hall from which gases can be excluded by self-closing doors.

Large plants are to have helmets which will permit the wearer to reach any part of the system without suffocation, at least one helmet for plants of 25 to 75 tons and at least 2 for over 75 tons capacity, these helmets to be kept in an accessible case near the doorway leading from the refrigerating machinery room.

To permit quick and sure control, pipes containing refrigerant under pressure are to have conspicuous signs attached stating the chemical contained therein, and signs shall designate the main supply and suction pipe in each room. Also valves which control main sections of the system to separate them in case of emergency must be plainly labeled.

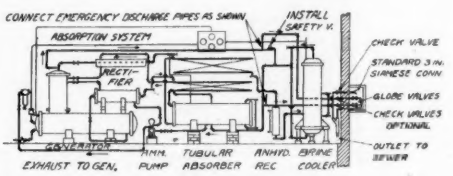


FIG. 3. EMERGENCY CONNECTIONS FOR ABSORPTION PLANT

Surplus refrigerant may be stored to the amount of 2 cylinders or if necessary to 10 per cent of the charge of the plant, but must be kept in a cool place.

Certificates

No plant of over 3 tons refrigerating capacity may be operated unless under charge of a person holding a Certificate of Fitness from the Fire Commissioner or who has been certified as competent by a Department of the City of New York having proper authority. Also, a Certificate of Fitness is required of each person directly in charge of the operation of refrigerating machinery during each shift.

For plants of less than 3 tons capacity, the Fire Commissioner may grant exemption from the foregoing provisions, except as to flames and exits, if a certificate of approval has been issued for each machine. But no plant producing refrigeration by means of gases under pressure may be operated in the city without a permit, application for which must state the builders rated capacity in tons, refrigerant used, amount of surplus refrigerant stored, number of shifts and time operated during 24 hr., and give name and address of applicant and location of plant.

Certain of these provisions are for departmental convenience, but the spirit of the requirements, to provide safety for occupants of the plant and surrounding premises, is desirable of application in all plants, and most of the safeguards are such as should be found in every plant in all locations.

Some Refrigerating Experiences

By C. T. Baker

RECENTLY I was called to give some advice regarding the operation of a small refrigerating plant in a hotel. Upon looking the plant over, a number of reasons were found to explain the trouble experienced. The plant consisted of one 10-ton vertical single-acting refrigerating machine, motor driven; one small triplex pump, also motor driven, used for circulating brine through the cold storage boxes in the kitchen, and a brine tank fitted up with 1¼-in. direct expansion coils for brine cooling. The brine tank was approximately 6 ft. deep, and the stands of direct expansion ammonia coils were approximately 5 ft. 6 in. high.

It was found that there was only 18 in. of brine in the tank; consequently about 4 ft. of the ammonia coils were uncovered. The brine pump was examined and the valves and springs were found in bad condition and the valves leaking.

The suction line to this pump was found nearly stopped up with dirt and trash which had been allowed to collect in the tank. A highly compounded steam cylinder oil was being used to lubricate the ammonia compressors instead of ammonia oil. The temperature of the condensing water was 70 deg. F., but the condensing pressure operated against was 210 lb. (gage).

There was approximately a half charge of ammonia in the system and the inner tubes of the double pipe ammonia condensers were nearly stopped up with scale and deposit.

Dirty condenser tubes and air in the system were responsible for the abnormal condensing pressure.

No thermometer was used in the brine tank nor any of the cold storage boxes, consequently no one knew what temperatures were being carried.

Ice cream salt was ordered and brine in sufficient quantity was made to fill up the brine tank and submerge all coils. New valves and springs were placed in the brine pump and the suction line was cleaned out. The plant was shut down and the ammonia system purged to remove the air. The inner tubes of the ammonia condensers were scraped and otherwise cleaned. Sufficient anhydrous ammonia was put into the system to bring the liquid level up in the liquid receiver to the proper height. Ammonia oil was substituted for steam cylinder oil for compressor lubrication, and a thermometer was placed in the brine tank.

When the plant was again put in service the condensing pressure stood at 160 lb. instead of 210 lb., as formerly, and in place of having to operate the compressor 14 hr. out of 24, the running time was reduced to 8 hr.

As they were paying 4 cents per kw.-hr. for current to operate the compressor, this reduction in running time meant quite a saving. A further saving was effected, due to the elimination of goods and meats spoiling in the storage boxes, and also a decided reduction in the ice bill was made.

The improved operation reduced the condensing water consumption 15 per cent; this water was purchased from the city.

The management does not believe in employing first-class engineers; they say: "We can't afford to, we must have a cheap man."

Ship Draftsmen Needed

THE Navy Department of the United States finds itself greatly hampered at this time, for lack of ship draftsmen. Large appropriations are available for new construction, and arrangements have been made for facilitating construction, but all work undertaken at Government yards is retarded by shortage of draftsmen to get out the plans for the new ships of the Navy. Under these conditions, applicants are being accepted without being assembled for examination, being rated upon physical ability, education, training, experience and ability, and applications may be sent at any time, and will be acted upon promptly, with employment to follow at once.

This work is a matter of loyal service to the Government by those who have the ability to meet the requirements, and should appeal to all who are in position to give assistance. The ratings are on the following scale: Physical ability, 10; education, training, experience and technical ability, 90. In rating technical ability, the degree of difficulty and importance of work performed, length of experience, and the rating of the applicant as a draftsman or workman will be considered. Applicants must have reached their 18th birthday on the date of making application. Four grades are offered:

For the first grade, compensation is from $3.28 to $4 a day. The requirements for an applicant are, graduation from a technical school or college of recognized standing, with one year's experience in ship building; or graduation from or senior year standing in the naval architecture course of a technical school or college of recognized standing; or 3 years' experience in shipbuilding, one year of which must have been in the drafting room.

For the second grade, the rate of pay is $4 to $5.04 per day. The requirements are, graduation from a technical school or college, with 3 years' experience in ship drafting; or graduation in naval architecture from a school or college of recognized standing, with one year's experience in ship drafting; or 5 years' experience in shipbuilding, 3 years of which must have been spent in drafting.

In Grade 3, pay is $5.04 to $6 a day. The requirements for application are, graduation from a technical college, with 5 years' experience in ship drafting, 2 of which have been spent on original work under nominal supervision; or graduation in naval architecture from a technical college, with 3 years' experience in ship drafting, 2 of which have been spent on original work; or 7 years' experience in ship drafting 2 years of which must have been spent on original work under nominal supervision.

For Grade 4, payment is over $6 a day, and applicants must qualify under one of the groups of Grade 3, and in addition must have had one year in ship drafting in a supervisory position.

The ratings on these grades are for original appointment only, and persons with the minimum qualifications for a grade will be appointed only at the minimum salary of that grade, promotion being dependent on the record subsequent to entering the service.

Applicants will be admitted to the examination regardless of residence and domicile, but those desiring appointment to the apportioned service in Washington, D. C., must have been actually domiciled in the State or Territory in which they reside for at least one year previous to the date of making oath to the application, and must have the county officer's certificate in the application form executed.

Form 1312 for the application can be had by applying to the Civil Service Commission, Washington, D. C., stating the title of the examination desired, or from the secretary of the United States Civil Service Board, located in the Post Office Bldg., Boston, Philadelphia, Atlanta, Cincinnati, Chicago, St. Paul, Seattle or San Francisco, and in the Custom House in New York, New Orleans and St. Louis. Applications should be properly executed, excluding medical certificate, and filed with the Commission at Washington as soon as possible, the exact title of the examination being, Ship Draftsman (Male), Navy Department.

Your Flag and My Flag

By Wilbur D. Nesbit

Your flag and my flag,
And how it flies today
In your land and my land
And half a world away!
Rose-red and blood-red
The stripes forever gleam;
Snow-white and soul-white—
The good forefathers' dream;
Sky-blue and true-blue,
With stars to gleam aright—
The glorified guidon of the day,
A shelter through the night.

Your flag and my flag!
And, oh, how much it holds—
Your land and my land—
Secure within its folds!
Your heart and my heart
Beat quicker at the sight;
Sun-kissed and wind-tossed—
Red and blue and white.
The one flag—the great flag—
The flag for me and you—
Glorified all else beside—the red
And white and blue!

LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

Effects of Covering Pipe

THE FOLLOWING tests were taken before and after covering steam line from a manifold to the entrance of steam to 2000 ft. of coils in a cylinder used for the purpose of heating timber treating liquid.

Distance from manifold to intake about 200 ft.

Distance from intake to discharge of coils, 2000 ft.

Number of return bends in coils, 16.

Distance from superheaters to intake, about 350 ft.

Distance from superheaters to discharge, 2350 ft.

Size of coils, 1¼ in.

COMPARISON OF DROP IN TEMPERATURE OF STEAM DURING TRANSMISSION IN BARE AND COVERED PIPES

Hour	Intake temp.	Discharge temp.	Superheated steam temp.	Temp. liquid	Pres. steam lb.	Temp. decrease, Intake to Discharge	Temp. decrease Boiler to Intake
#1 - Before Covering -- 10 hr. test. 12/13/16							
7	244	230	382	225	95	6%	138
8	247	227	382	225	95	8%	135
9	250	238	380	225	100	5%	130
10	250	230	368	225	100	8%	118
11	250	250	356	225	95	0%	114
12	248	228	370	225	95	8%	122
1	248	228	370	225	105	8%	122
2	236	230	370	225	105	4%	132
3	238	230	370	225	105	4%	132
4	238	230	378	225	95	4%	140
#2 - Covered Same Lines - 7 hr. test. 1/11/17							
6	368	212	410	190	105	44.8%	42
7	286	198	408	190	110	30.8%	122
8	296	200	418	192	105	32.4%	122
9	282	215	408	193	105	23.7%	126
10	268	216	410	194	105	19.4%	142
11	340	238	406	194	105	30.0%	66
12	340	238	406	212	100	30.0%	76
#3 - Covered Same Lines - 9 hr. test. 1/12/17							
7	332	170	398	140	90	49%	66
8	335	200	402	165	90	40%	67
9	335	235	394	190	100	30%	59
10	285	190	400	196	105	33%	115
11	274	190	390	194	100	30%	116
12	270	195	385	193	95	30%	115
1	270	180	383	190	95	33%	113
2	330	230	412	188	105	30%	82
3	330	225	390	212	100	31%	60

Size of steam lines, 8 in. to manifold.

Size of steam line to intake, 2½ in.

Size of discharge to exhaust header, ¾ in.

It will be noticed that as the material within the cylinder, to be dried, becomes dry and the evaporation period is nearer the finish, the heat being taken up within the retort shows a decided decrease.

In table No. 1 the material is about dry and a decrease from intake to discharge is apparent from 4 to 8 per cent and a lower intake temperature.

In table No. 2 the material is green, and it is apparent that a considerable quantity of heat is being taken up in the evaporation of moisture, showing a decrease from intake to discharge of 30 to 44.8 per cent with a higher intake temperature.

In table No. 3 we have the same results as in No. 2.

One feature of interest is the fact that during tests Nos. 2 and 3 the evaporation took place at a lower temperature of the liquid, but at a higher rate, due to the boiling being done under 24 in. of vacuum.

Increase of temperature of superheat is due to the close of dampers, thereby retaining the heat in the combustion chamber.

M. A. THOMAS.

Constructing a Flue Gas Pyrometer

THE ACCOMPANYING drawings show a flue gas pyrometer, made by the writer, from a steam gage.

Figure 1 shows the movement in the gage case, the dial and pointer being removed. The gage tube, or spring, is cut off from piece A. The original gage movement, H, being used, but having in addition the lever, B′, and spring D, to force lever B′ in contact with brass rod B. A stop, F, is provided to limit the movement of the lever. A light spring, E, is also used to take up any lost motion in the connections.

The rod, B, is of brass, ¼ in. in diameter, and 27 in. long, the hole in A being drilled out to allow the rod to move freely. The rod, B, is enclosed in a piece of ¼-in. iron pipe, C, and fastened firmly at the lower end by being screwed into a ⅛-in. pipe plug, G, this plug is screwed into the ¼-in. pipe as shown. The dimensions of the movement should be as shown in Fig. 2 (or in the same ratio) to give a scale deflection from 100 deg. to 600 deg. F. when using a brass rod 27 in. long. As

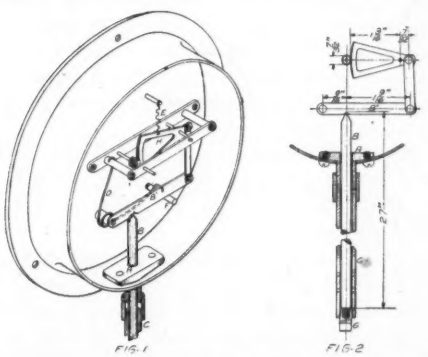


FIG. 1. PERSPECTIVE VIEW OF PYROMETER MECHANISM
FIG. 2. ELEVATION OF PYROMETER MECHANISM GIVING DIMENSIONS

the expansion of the rod, B, is more than the iron pipe, the rod will have a movement of approximately 0.058 in., with a 600-deg. rise in temperature. This expansion being multiplied by the gage movement, will give about one revolution of the dial pointer. The iron pipe, C, should be perforated with several small holes, as shown in Fig. 2.

To calibrate the instrument: Paste a paper dial on the original steam gage dial. Submerge the stem, C, in a barrel of water to the same distance that it will be inserted in the boiler flue when in use, a thermometer being placed in this water. Raise the temperature of the water to 100 deg. F. and place the gage pointer on the spindle to register at 0 on the dial. Mark this 100 deg. Raise the temperature of the water to 125, 150, 175 and 200 deg., marking the position of the pointer on the dial to correspond to these temperatures. We now have the instrument calibrated from 100 to 200 deg. in 25-deg. marks. Divide these spaces into 5 equal parts; this will give 5-deg. divisions.

The higher temperatures are obtained as follows: Take a piece of brass or copper and weigh it. Set this in the flue alongside the pyrometer, allowing it to remain in the hot gases until it has the same temperature as the gas. Mark the position of the pyrometer pointer on the dial. Remove the brass or copper piece and instantly drop it into a can of water of a known weight and temperature. The flue gas temperature is then found by the formula, $T = \frac{W\,(F - O)}{S\,w} + F$, where T = the temperature of the heated metal, W = the weight of the water, w = weight of metal piece, O = original temperature of the water, F = final temperature of the water, S = the specific heat of the metal, which for brass is 0.0939, for copper is 0.0951.

The writer used a piece of brass weighing 2 lb., water 5 lb. The original temperature of the water was 80 deg., the final temperature, 95 deg., this making the formula:

$$\frac{5 \times (95 - 80)}{0.0939 \times 2} + 95 = 493 \text{ deg.}$$

Call this 495, marking this on the pyrometer dial at the point registered by the pointer when the brass piece was removed from the flue. On each side of this point set off the 5-deg. and the 25-deg. points until the dial is calibrated.

The writer does not claim that this instrument is absolutely correct, but it is far better than none at all, and will show the temperature variations of the flue gas, besides being sensitive enough to show at once the variation in the temperature of the gas when the damper is opened or closed.

I find it very convenient in connection with the CO_2 analyzer and draft gage, constructed by the writer, as shown in the Aug. 15, '16, and Mar. 1, '17, issues of Practical Engineer.

Following are some of the readings taken with these instruments on a 300-hp. Stirling boiler, using Jones underfeed stokers and forced draft, the pyrometer and CO_2 analyzer being inserted side by side in the last pass below the damper:

Furnace Draft	Temp. Flue Gas	CO_2
0.20	360	7.4
0.12	400	10.2
0.10	420	12.4
0.04	405	13.
Balanced	470	13.
0.05	510	14—Fires stirred.

As will be seen, these show that there are air leaks in the setting, as the CO_2 and temperature drop when the damper is opened. The leaks were found around the clean-out door frames. R. L. MOSSMAN.

Economizing on Condensing Water

THE DRAWING shows how water may be used from ammonia condenser to supply part of the steam condenser requirements.

All pumps discharge into the water header, A, in the engine-room, which supplies the water for the house, condensers, etc. A 3-in. line, B, leads from the water header to the steam condenser and is regulated by the float valve, C, through which more or less water is discharged according to the water level in the box, E, which supplies the condenser with injection water.

The engine may be started up condensing or noncondensing. If started noncondensing, it should run slowly until the desired vacuum is obtained, then it may be brought up to speed. The condenser may be started by opening valve F until the vacuum is obtained, then it may be closed and the water will be drawn through pipe G.

There is really no use for valve H or D, although valve D may be closed when working on the float valve or in the box.

The overflow water from the ammonia condenser is not quite enough to supply the steam condenser in certain weather conditions, therefore the extra amount of water is obtained from the water header.

The box is also fitted with a tell-tale, J, the weight of which is inside the engine room, the overflow pipe, K,

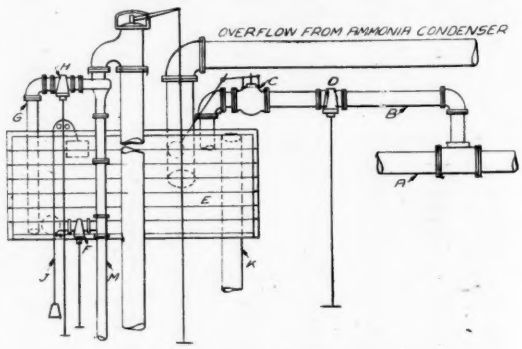


DIAGRAM OF CONDENSING WATER PIPING

and the discharge pipe, M, are led to the reservoir, which contains well and lake water which supply the house and fire pumps. The average vacuum is 26 in.

WM. B. NOLD.

Overhauling the Blowoff Valves

WHEN I took my present position, I found the blowoff valves on the 4 boilers much the worse for wear and, as they are one of the most important parts of any steam plant, I at once overhauled them. Some of the studs were so badly corroded that they broke off and had to be drilled out. Not being able to procure stud bolts, I used the ordinary bolt, obtaining the correct length in the following way:

First, put gland in place and run nut on bolt as far up toward head as possible; screw bolt through gland into valve bonnet until it reaches the bottom;

pack stuffing box and run nuts down against it and saw off. On account of old studs being broken and drilled out and a larger size used, I preferred this way to hunting broken pieces.

I have found these and other bolts in blowoff valves greatly damaged by corrosion. Why this part of a boiler is neglected is more than I can figure out. J. C. LEE.

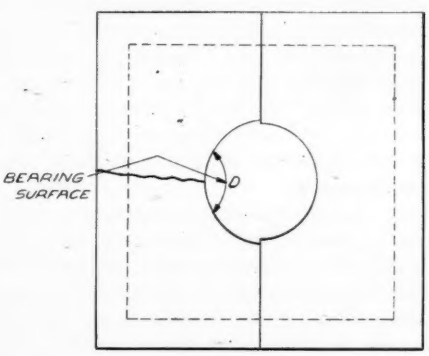
A Day of Trouble

WE HAVE all had a day of trouble when everything seems to go wrong at the plant, with a lot of small breakdowns. When a fellow has made plans to spend the evening at a nice show, sure as fate that's the day when things go wrong, and he is called on to work at night.

The first sign of a bad day came shortly after starting up. The engine started to choke with water, and the drains had not yet been closed; the result was that we had to run slow for 10 min. until the flooded boilers were down to their normal level, for this is where it came from.

While renewing a glass that had blown out, the water tender had neglected to tend the feed check, and high water was the result. After getting up to speed and carrying the load, a flapping noise was heard near the flywheel, and after watching awhile I knew the belt was breaking; however, she ran till noon, then a few rivets were put in to hold her together until night, when she had to be patched and cemented.

The next thing on the program was a leak on the 4-in. air pipe line from the compressor tank. This kept getting worse, and complaints were coming about low pressure, until we fitted a Simplex pipe clamp on for a temporary repair. During the afternoon a heavy thump developed in the engine crosshead. This kept me worried until night time, when I could look for the trouble, which I found to be a loosened key and gib.



REDUCED BEARING SURFACE ON CROSSHEAD BRASS

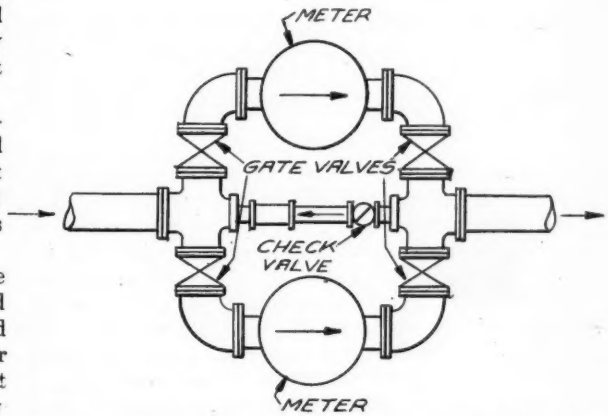
Further inspection showed that the pound had cracked the head end brass and to key up this broken brass so that it would not pound, would make her smoke in no time.

No spare brass was available, and it would take at least a day to get one. By cutting the width of the bearing surface down on the broken half brass, as shown in the sketch, and keeping her flooded with oil, she ran pretty fair.

It was past midnight before these repairs were completed, and a weary engine room force washed up to go home. C. H. W.

Water Meter Connections

A FEW years ago we experienced a great deal of difficulty in keeping the meters running that supplied water to a railroad round house and machine shop. The pressure ranged from 125 to 150 lb. per sq. in. The meters used were of the disk type and the disks would



WATER METERS IN PARALLEL, BYPASS AND CHECK VALVE TO PREVENT BROKEN DISKS

be broken probably by the rapid closing of the valves, causing a water hammer, the pressure wave acting in the opposite way or back against the meter.

This was obviated by putting in a bypass around the meter with a check valve in the bypass so that the check would lift and prevent the shock from breaking the disk.

We replaced one meter by two set in parallel, although this arrangement is not necessary, but only convenient, as one can be removed for repairs or any other purpose without interruption of the service. This also gives a check on the way the meters are running as a stopped meter can readily be detected. Two meters set in this way need not run exactly alike, for the meter that works the easier will pass the most water and both may be correct. The sketch shows this form of setting which has proven to be a money saver and does away with the disputes when having to render estimated bills.

H. L. SHERMAN.

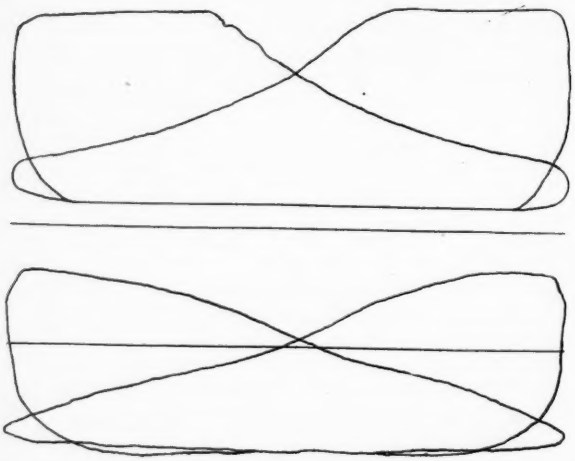
U. S. CIVIL SERVICE COMMISSION announces an examination for architectural draftsman to fill a considerable number of vacancies in the Bureau of Yards and Docks, Navy Department, Washington, D. C., and at navy yards and other naval establishments of the United States, at salaries ranging from $3.04 to $6 a day. Duties will be architectural drafting and the preparation of working drawings, specifications, and details. Competitors will be rated on education, preliminary training and experience. Applicants must not have reached their fiftieth birthday on the date of filing application. Until further notice applications will be received at any time and the papers will be rated immediately upon their receipt. Apply for Form 1312.

Problems For Discussion By Readers

What Would You Do If You Had These Conditions To Meet?

How Can Diagrams Be Improved?

INDICATOR cards taken from an Allis-Chalmers cross compound engine are shown herewith, and I would like to hear from some of the readers of Practical Engineer as to the changes that should be made in valves. The



DIAGRAMS FROM ALLIS-CHALMERS CROSS COMPOUND CORLISS ENGINE

engine cylinders are 24¼ and 56 by 48 in.; boiler pressure, 140 lb.; receiver pressure, 12 lb.; vacuum, 25½ in.; speed is 99 r.p.m. J. B.

Eliminating Oil from Condensate

I AM IN charge of a pumping station and some time ago we installed a new engine. The exhaust of the engine is to a surface condenser. To my knowledge, the only reason a surface condenser is installed is to return the water to the boiler; but before doing this, some effort must be made to get the oil out of the water. We have tried 2 different kinds of oil separators, but separated only about 25 per cent of our oil, so we have rigged up a homemade oil tank separator of our own, and according to the Hartford Insurance Co. analysis, we are separating about 65 or 70 per cent; but they would not recommend this water to be fed back to the boiler. The analyses show 2.66 grains to the gallon, or 4.55 parts to 100,000.

I would like very much to return this water to our boiler, as we can effect a nice saving. We could return more than 90 per cent of our condensate to the boiler. If we cannot return this water to the boiler, we must use water that contains 40 grains of incrusting matter to the gallon. We have no filtering system or water softener, so we use soda ash to neutralize and prevent hard scale, also many heat units are lost by blowing the boiler often. Now, which of the two waters is the better to use, the condensate which has 2.66 grains of oil to the gallon, or well water that has 40 grains of solid to the gallon?

I am going to try to separate still more of the oil. This oil that reaches the boiler is mineral oil and, as near as we can figure, is about one quart per 24-hr. day in a 150-hp. boiler. The engine steam consumption is 50,000 lb. a day, which is about equal to 6,000 gallons and 2.66 grains to the gallon $= \frac{2.66 \times 6000}{7000} = 2.28$ lb. of oil. Our total water evaporation is about 70,000 lb. per 24 hr. What number of grains of oil per gallon would be safe to put in the boiler; or, in other words, how near does the 2.66 grains per gallon come to the safe point for boiler feed water; and if we use this water, how many weeks would you operate the boiler before draining and cleaning?

What damage does mineral oil do to a boiler, especially when about 92 per cent is pure water feed with it? Did you ever hear of cylinder oil taken from separator being used again in the cylinders? W. V.

Indicator Diagram Criticisms

IF ENGINEERS who desire information on indicator diagrams and remedies for valve troubles would submit the size of the supply and exhaust pipe, state whether the engine is working on a heating system against a back pressure or exhausting to the atmosphere, draw the atmospheric line and mark the head and crank ends, it would be of considerable assistance to those desirous of offering suggestions.

In reply to A. L.'s inquiry as appearing on page 326 of the April 1 issue, I would state that his valve setting is not so difficult of correction as it appears. His trouble on the left-hand end is due to the length of the radial rod connecting the valve stem to the wristplate, which causes the valve to open after the piston has started on its journey. Adjust the length of this rod to open the valve earlier until the admission line on the left-hand diagram looks like the right-hand diagram, advance the eccentric on the shaft to do away with the round corners, equalize the load by adjusting the governor rods and speed up the dashpots.

The freak diagram of W. W., page 327 of the same issue, is not so freakish as it looks at first glance. A friction diagram from an automatic engine with a shaft governor when the governor is hunting is very different from a diagram taken from the same engine when carrying part or full load. This diagram shows the necessity

of knowing under just what condition this engine exhausts its steam. Does it exhaust into a vacuum system of heating or against a back pressure or direct to the atmosphere? There is no way of telling from this diagram.

W. W. should have sent a working load diagram. Looking at this diagram, we see good compression and admission lines, prompt cutoff and neglecting the waves on the expansion line (caused by the indicator) a good expansion line, all of which indicate the fault, if fault it can be called, to be due to the governor hunting, caused probably by some slight wear on the governor pins or a lack of lubrication at that point.

Taking up J. A. W.'s diagrams appearing on the same page, we find a diagram somewhat better than the average and yet not good enough for the type of engine from which it is taken. All events appear a little late, the remedy for which is to advance the eccentric on the shaft ¼ in.; adjust the length of the radial rods actuating the exhaust valves to do away with the heel when exhaust valves open. The load is not equal on both sides of the piston and may be the cause of the knock at light loads. Equalize the load by adjusting the reach rods from the governor. If the knock occurs at light load, this will stop it, otherwise, the knock is due to causes over which the valve setting has no control.

C. E. C.

In regard to the card taken from a Fitchburg engine by W. W., as shown in April 1 issue, I would advise him to clean thoroughly the cylinder and piston of his indicator, giving it a good oiling.

The zigzag lines indicate that the indicator piston is sticking. J. A. Wise.

In the April 1 issue is a pair of diagrams by A. L., who inquires, "What is wrong?"

In my opinion, he has a late steam admission, and too early exhaust opening. I would advise moving the eccentric back, making the exhaust valves open later, and close later. This, of course, will make the steam admission later; to overcome this, shorten the steam rod. I would also try the valves and piston for leakage, and if they leak, put them in good condition.

J. A. W. has diagrams in the same issue and tells of the engine knocking. An engine will sometimes knock when everything is mechanically in good condition and getting plenty of oil. It is then sometimes due to the valve setting. Sometimes the compression is too low, sometimes too high; sometimes it is due to the admission of steam. A short time ago, I indicated an engine which had a knock in one end; it was caused by the compression being too high.

In the case of J. A. W. I would advise him to give the steam valve on the head end (left-hand diagram) a later opening. Also shorten both exhaust rods, giving the exhaust valves an earlier opening and a later closure. This will do away with the "toe" on the card, and also decrease the compression.

The knock may be caused by the piston slamming, or something loose about the piston, in case it is built up; but it is highly probable the engineer has already examined things carefully. Tom Jones.

In J. A. W.'s question on page 327 of April 1 issue, he says that his engine develops a hard knock at times and runs smooth at other times.

I had some experience of this kind myself. I judge by the cards that J. A. W. has taken them with side pipes and possibly he has used a T in center instead of a 3-way cock. I believe if he will put his indicator direct on the cylinder, he will find that he has too early admission. I had quite a lot of trouble of this kind and by putting my indicator direct on the end of the cylinder, I found the valve was early, but still with the side pipes the cards looked good. I see one end has several pounds more initial pressure than the other, and also very high compression and late release. I would advise him to try this remedy and see if he doesn't find the knock. Since I had my trouble I use 2 indicators, one on each end of cylinder, and find I have better success. J. L. S.

In reply to the question "Why the Knock?" by J. A. W., on page 327 of the April 1 issue, I would say that I have had the same trouble occur in several Corliss engines I have operated. The first time, the engine was a St. Louis Corliss, 30 by 48 in. At times, the engine would give a sharp knock on the head end at every stroke for hours at a time and then run smooth again for a time. I keyed up the connecting rod and crosshead brasses to the limit, and took up on the shoes, all to no avail. I then took off the head and tried the piston for center and there found my trouble. The piston was of the built-up type, spider and bull ring; I found that the ⅛-in. low piston was dragging. Consequently, when the engine was working hard, the steam entering cylinder would have a tendency to raise the piston, giving the sharp knock. I raised the spider by adjusting screws until it was a fraction above center, put back the cylinder head and started up with a sigh of relief, as the knock had disappeared and the engine ran as smooth as when first installed. A. L. Mitchell.

In the April 1 issue, J. A. W. asks for suggestions for eliminating a knock in the cylinder of his Corliss engine. From the appearance of the diagram submitted, both exhaust valve rods should be adjusted to open the exhaust valves earlier, especially the one corresponding to the right-hand end of the card.

This will make compression begin later, which is desirable, and I would also increase the lead on both ends until the lead line rises perpendicular to the atmospheric line.

There may also be some other cause for the knock, other than the correct setting of the valves, although if this is corrected first, the knock may disappear. If it still remains, it will be necessary to examine the engine thoroughly to locate the cause of the trouble.

J. H. Case.

Bending Boiler Tubes

I fully believe that the theories of both G. H. W. and A. C. M. as advanced on page 133 of the Jan. 15 issue and on pages 327 and 328 of the April 1 issue respectively, are born of imagination, and go wide of the mark as being of any value to M. F. T.'s request for a practical answer. One qualified to give such an

answer would be an engineer who has experienced this distortion of tubes, and determined the cause.

The writer had the misfortune of seeing four B. & W. boilers of the plant short of water during a peak load, with the consequent shut-down and rescue of the boilers from this precarious condition. The result of this accident was the warping of 2/3 of all the tubes, and they did not curve upward; they all deflected downward, so that the center of their length was ¾ in. lower than the ends.

This is a practical experience, and would seem worthy of mention. Now, if the theory advanced by Mr. Wallace is correct, it puzzles the writer why the lower row of 4-in. tubes of the B. & W. boiler on which the roof baffle brick always rests, do not bend upward, due to the intense heat applied to the lower sides. Surely the fire tile resting on the top side must insulate them, and cause a large difference in the temperature of the two sides, yet I fail to note any of my lower 4-in. tubes in some 6-yr.-old boilers bent upward. C. H. WILLEY.

IT IS over a year ago since this question was asked by the engineers at our plant, and I believe it was solved then, as we have had no occasion to ask the same question since. When I read the explanation given by Mr. Wallace in the issue of Jan. 15, I was satisfied to accept his theory as correct; but when I read the article by A. C. M. in the issue of April 1, I though I would come to the support of Mr. Wallace and tell what our conditions were at the time the tubes bent upward.

Almost all the tubes in the bottom row of five 400-hp. B. & W. boilers were affected in this way. The furnaces had stationary grate bars and the dampers were hand regulated. It took quite a while to clean the fires, as they were always very dirty. The load varied greatly; at times, the boilers would be pushed almost to their capacity, then the load would suddenly drop off. At this period, instead of firemen closing the dampers to prevent the steam pressure from reaching the pop, they resorted to the very bad practice of opening the furnace doors, which allowed the cold air free access into the furnace, striking directly the lower side of the tubes. Now, the lower side, being suddenly cooled, contracts more than the top side, which is almost as hot as it was before the furnace door was opened, so, the lower side striving to shorten itself while the upper side is still in expansion and striving to retain its length, there is only one thing which can prevent the tube from ultimately bending upward; that is, cool the top side as suddenly as the lower side—but that is impossible.

A. C. M. points out that the top side of the tube is cooler than the lower side because the hot gases hit directly on the bottom and indirectly on the top. And so it works the same way with the cold air entering the furnace from time to time. It hits directly on the bottom side of the tubes and indirectly on the top side, which leaves the top, as I said, almost as hot as before the door was opened. Now, according to A. C. M., the tubes should have bent downward, but instead they bent upward. How does he account for that?

The practice of opening the doors was strictly prohibited, the bent tubes were taken out and new ones put in; shaking grates and damper regulator were installed. The load has greatly increased and varies just the same, but we have no more trouble with tubes bending upward. The conditions that we had when the tubes bent upward justify the explanation given by Mr. Wallace more than the one given by A. C. M.

D. F.

Low Water—What Would You Do?

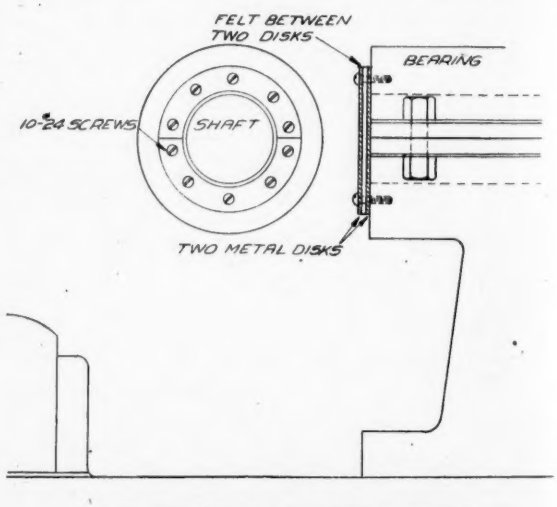
NOTICING the discussion on what to do in the case of low water, I will give my experience.

I have charge of a battery of 5 boilers which were fired by hand by two firemen. On going past one, I noticed the glass showed no water. Calling the fireman's attention to it, I asked him where the water was, and he replied that it was full. As 2 275-kw. generators and other machinery were on, I told him to blow down; but, trying the water glass blowoff and seeing no water or indications of it, I pulled the fire and cut it out of the line. It was a back feed through the blowoff, having a valve in the line next to the boilers between the check valve and boiler. I started at the check valve and found the check had come loose and had wedged against the globe valve. After removing it, I tried my blowoff and saw I had water in my boiler, enough to keep the shell from burning. The fire being pulled, I started my pump, got water in it and fired up, with no bad results.

R. L. W.

Remedy for Troublesome Bearing

ON A PARSONS turbine running at a speed of 3600 r.p.m. one of the bearings near the exciter would throw considerable oil into the windings and on the floor of the engine room. To overcome the trouble, I made two disks of 1/16-in. iron and placed a piece of heavy woolen felt between them. The disks were drilled for 10 No. 24



OIL COLLECTOR FOR TURBINE SHAFT

screws and then split through center so as to get it around the shaft, and the end of the bearing was drilled and tapped to hold them in place. The center hole in the disk was bored ⅛ in. larger than the shaft so it would not rub and the felt was cut so as to fit the shaft snugly. It cured our trouble; perhaps F. H. can use it.

H. J. WOLLAM.

Operating Barometric Condensers

IN REPLY to W. E. B. on page 326 of April 1 issue, as to the proper way to operate a barometric condenser, I should give the following directions: In starting the engine, exhaust to atmosphere until the load is put on the engine, then open priming valve and when you have your vacuum, open injection valve and shut priming valve.

In case you should lose vacuum while the engine was running, just leave the throttle alone and shut the injection valve, then open the priming valve until you get vacuum again, then open the injection valve and close the priming valve. This is the way it has been done at one plant for 8 yr. and is entirely satisfactory; they have never had an accident due to water from condensers. J. B.

IN REPLY to the questions asked by W. E. B., I wish to offer the following:

Assuming the condenser to have been properly installed and to have operated satisfactorily, the vacuum is lost while the engine is running.

When the job is put in correctly and proper drainage maintained between the condenser and the cylinder, water cannot come over to the cylinder if the discharge pipe is free.

Whether it will be necessary to stop the engine to build up the vacuum depends upon local conditions. Generally the vacuum may be built up with the engine running.

The accompanying sketch shows the usual way in which this condenser is piped up. If the condenser is not of proper size or has air leaks in the piping, if there is an irregular supply of injection water, or the load comes on before the engine is up to speed, or with a long run of pipe between condenser and cylinders, it may be necessary to stop the engine. Then build up as high a vacuum as possible and start the engine. When the vacuum is lost with the engine carrying load, when all has been well up to this time, the trouble will usually be found due to some trifling cause which, when removed, allows the vacuum to build up to normal.

Disregarding general pump troubles, poor vacuum or total loss of vacuum may be caused by any one of the following causes:

The strainer may be clogged on the injection pipe, reducing the flow of water.

Porous pipe between cylinders and condenser without a thorough application of asphalt paint will also be found the cause of such trouble.

The relief valve cap has a rubber packing ring which, due to the clapper being allowed to hammer on its seat, soon leaks and ought to be renewed. These valves ought to be water sealed. If they leak, and usually they do, the sealing water may be cut off so that they are not sealed.

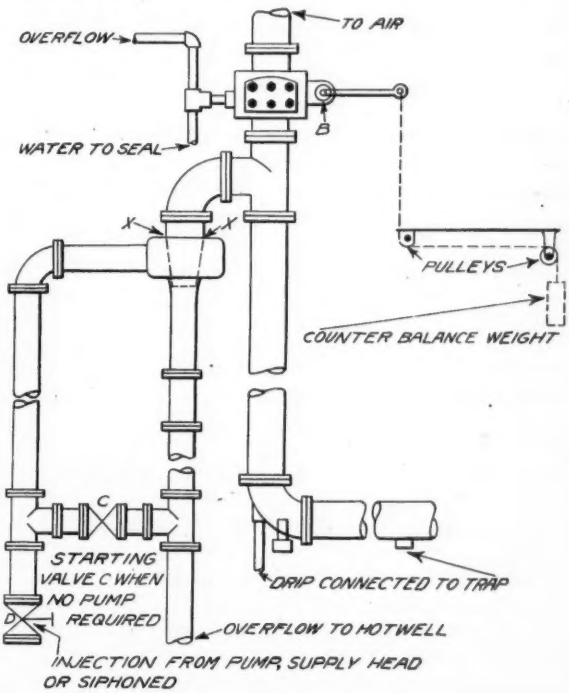
Of course, the stuffing boxes on the engine and pump, when one is used, ought to have proper attention and be kept tight. The stuffing boxes on all water lines to the condenser should be included in this, also the vacuum breaking valve and its disc renewed when required.

The trap and drain valves which discharge the condensation from the exhaust pipe should be frequently examined to be sure that they are clear and seat properly.

Care must be taken to see that the stuffing box on the relief valve shaft at B is not so tight as to make the valve sluggish or it will be difficult for it to seat itself. The counterbalance weight must not be too heavy or the valve will not close automatically when it opens. Care must be taken to see that the chain or cable used to connect the counterbalance weight to the relief valve is in the guide pulleys.

When no pump is used to supply injection water, one can usually re-establish the vacuum by starting the engine in the regular manner, in the meantime exhausting out board.

First open priming valve C and after a few seconds open the main injection valves, lowering the relief valve onto its seat. In a few seconds the vacuum builds up to 18 in. or so, when starting valve C is closed and vacuum regulated by injection valve D.



TYPICAL BAROMETRIC CONDENSER CONNECTIONS

A forced primer would be used in the same way. The pump, when necessary, could have been started and its speed governed according to the vacuum carried.

Careful inspection of the plant for some of the abovementioned troubles will do much toward eliminating trouble and one must use his own judgment, knowing plant conditions, as to whether it is necessary to stop the engine before the vacuum can be built up.

RECEIVER.

A SUMMARY of American efforts within the last century shows that, while our inventions have contributed much to the world's advancement, our genius has been expended in practical applications rather than in discoveries in the field of pure science.—Brander Matthews.

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Engineers' Wages in the Small Plant

In large plants, where power costs form an important part of the expenses of the factory or works, the power engineers are likely to be noticed by the owner or manager and the importance of their work appreciated. In such circumstances the chances that adjustment of wages in proportion to the importance of the work, and, especially at the present time, in recognition of the needs of the men are at least possible, either by direct action of the owner or because of intervention of the chief in behalf of the power plant force.

But in the small plant, where one or two men on each shift are sufficient for engine and boiler room requirements, because of the small part that power expense plays in the factory accounts, and the separation of the power plant from the manufacturing problem, the engineers are liable to be overlooked and to get the worst of the struggle for increase of wages, unless the attention of the owner or manager is definitely called to the importance of power to the getting out of the product, and the consideration to which the engineering force are entitled in view of the demands made on them.

Few owners appreciate the long hours required, the early arrival in the morning in order that the fires may be broken out, steam raised, machinery inspected and oiled and everything in readiness to start up when the whistle blows; the hundred-and-one things to be done through the day, aside from firing the boiler and watching the engine, in order that all machinery may be kept running continuously and shut-downs avoided; the hasty luncheon that no time may be lost at the 1 o'clock start; the oiling and inspecting and adjusting and packing, the tending of fires and pumps and dampers to insure that no leaks or wastes lower the plant efficiency; the extra hour required to shut down, bank fires, look over the engine, repack a joint or a rod, adjust a valve rod; and sometimes the evening or night work when a particularly troublesome repair is needed; the Sunday joy of cleaning a boiler or repacking a pump piston or babbiting a bearing; and the responsibility that goes with all these to make certain that the safety of all about the plant is safeguarded, and that there is no weak spot in the installation that may cause interruption of service.

Considering the requirements in skill, knowledge, alertness and ingenuity, the engineer in the small plant is paid far too little as compared with his brother in the big station or the workman in the manufacturing end of the business.

Practical Engineer is not pessimistic as to opportunities in the power plant or the future of small plants; but we feel that the plant engineer is not generally appreciated at his real value by the owner, and that sentiment should be created to overcome this fault. Just how it can best be done is a problem, but it is a matter which each man in charge of a plant should have in mind.

Discussion of problems of the power installation with the owner, not in the way of criticism, but as matters of common interest, and the offering of suggestions for improvements in arrangement, operation and in equipment will create one point of approach. Report of work done and time spent will furnish another means of calling attention to the service rendered.

Comparative statements from month to month of machinery operated, power supplied, amount of fuel, oils and supplies used, will interest the "Old Man."

And most owners are fair minded, want their employes to receive value for service given and to have the opportunity to live comfortably and enjoyably. Frank discussion of cost of living and difficulties of "making ends meet" will usually be received in a friendly spirit and such action taken as the conditions of business warrant. But, in times of poor business and small returns, it is to be remembered that the owner may be having as hard a struggle to meet expenses in the works as the engineer is at home.

Where collective bargaining seems the best plan, we have no quarrel with that method so long as it is conducted in a manly spirit. Yet for most small plants, this is not feasible and greater benefits can be secured by the engineer from cooperation, and steady, determined insistence as to the importance of the work he is doing and the reasonable compensation to which his successful performance of that work entitles him.

Cooperative Coal Storage Yards

A suggestion made recently by the engineer of an industrial plant for relieving the situation developed by the shortage of coal appeals to us as a practical solution to the problem and should be given consideration by owners of small industries with community interests. Experience during the past few months has shown that the industries which have suffered from coal shortage are those which have no, or inadequate, coal storage capacity. To equip and maintain a near-by storage yard sufficient in size to insure against railroad tieups and belated deliveries is an expense to a small concern which in many cases seems unwarranted, but the suggestion that industries of a community combine their interests and maintain a storage yard of ample capacity to meet all likely conditions of coal shortage seems well worth putting into effect. Coal storage is no longer an experiment. There is, of course, some loss due to weathering, but this is largely offset by the advantage of having an adequate supply of coal available at a uniform price.

Such a yard should be equipped with the most convenient means for handling the coal to and from railway cars, industrial cars or trucks according to the facilities at the plants for handling their coal. The yard may be located at a reasonable distance from the plants it supplies so as to take advantage of the low price of real estate, but convenient transportation facilities are essential.

Although a local coal dealer may perform this service to a certain extent, it requires the investment of more capital than he is willing to tie up and for business reasons his customers must bear the fluctuations in market prices.

Surely this suggestion has merits and its practical application would help to solve one of the most trying situations for the industrial plant.

"THE MAN WITHOUT a purpose is like a ship without a rudder; a waif, a nothing, a no-man. Have a purpose in life . . . and having it, throw such strength of mind and muscle into thy work as has been given thee."

News Notes

J. D. VAIL, former manager of the Salt Lake City office of the H. W. Johns-Manville Co., has been appointed manager of the building materials department of that company's branch at Chicago. In the future the Salt Lake City office will be under the management of C. F. Cate. The Great Falls, Mont., office will be managed independently of Salt Lake City, by J. H. Roe.

THE B. F. GOODRICH RUBBER CO. announces a change in the personnel of its officials which brings L. D. Brown, who has been cashier of the First-Second National Bank of Akron, into the office of treasurer, succeeding W. A. Means. Mr. Means has been elected second vice-president of the company. He has been associated with the company for almost 20 yr., and during that time has seen it grow from a comparatively small plant with a $2,000,000 capitalization, to the $90,000,000 institution of today, which is rated as the largest of its kind in the world. For the past 7 yr. Mr. Means has occupied the office of treasurer and for 12 yr. previous to that was assistant treasurer.

NELSON BLOWER AND FURNACE CO., of Boston, Mass., has appointed Arthur W. Fonda to the position of sales and advertising manager.

W. S. RUGG, formerly district manager of the New York office of the Westinghouse Electric & Mfg. Co., succeeds C. S. Cook as manager of the Railway Department with headquarters at East Pittsburgh. Mr. Rugg is a graduate of Cornell University, and his connection with the Westinghouse Company dates back to the early days when the company had its plant at Garrison Alley, Pittsburgh, later being transferred to the Chicago office. In 1901, he was again transferred to the New York office as special engineer, and 8 yr. later became district manager of the New York office, which position he has held until this time. He has been prominently identified with the work of the American Institute of Electrical Engineers, serving for a time as one of its managers.

E. D. Kilburn, manager of the Power Department of the New York office of the company, has been appointed district manager of this office, to succeed Mr. Rugg. Mr. Kilburn became identified with the Westinghouse Electric & Manufacturing Co., at East Pittsburgh, later being transferred to the Syracuse office. Afterwards, he entered the employ of the Westinghouse Machine Co., with headquarters at New Haven, Conn., from which position he was transferred in 1915 to the New York office of the Westinghouse Electric & Manufacturing Co., to become manager of the Power Department. In November, 1916, his duties were enlarged to include the management of the Railway and Lighting Department of this office.

E. P. Dillon, formerly assistant to manager of the Railway and Lighting Department at East Pittsburgh, has been appointed manager of the Power Division of the New York office. Prior to his identification with the Westinghouse Electric & Manufacturing Co., in 1909, he was connected with the Colorado Springs Light & Power Co., Colorado Springs, Colo.

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

R. & D. Paracoil Evaporators and Feed-Water Heaters

IN THE R. & D. Paracoil evaporator, designed to provide a supply of absolutely pure distilled water for boiler feeding, drinking, culinary and other purposes, steam from any initial pressure to that of the atmosphere may be utilized. This allows operation as a single unit or with multiple effect.

Referring to Figs. 1 and 2, from which a good idea of the form of construction employed may be obtained, we note that in general this evaporator consists of a shell with swinging door to which is attached a new arc type of manifold and heating coils. The heating element being mounted in this fashion enables it to be swung outside for convenient inspection, cleaning or repairs, and due to its location within the shell an ebullition compartment is formed without the use of baffles, and complete circulation may be established without conflicting currents. A simple but effective form of baffle in the top of the vapor space eliminates all possibility of priming.

Top and bottom manifolds for steam inlet and condensation drain respectively are of cast iron or bronze, while the coils joining these manifolds are of seamless drawn copper and of such form as to provide for expansion and contraction and to eliminate strains on the joints. This permits scale to be removed by sudden flooding with cold water and blowing down at intervals, thus to a great extent doing away with the necessity of removing this scale by hand.

Joints between coils and manifold are made by slightly flaring the tube end and locking it between a tapered nipple on the manifold and a corresponding brass bushing. This is brought up tight by screwing into a brass lock nut that also threads into the nipple. If so desired, this joint may be had made up of 2-bolt flanges.

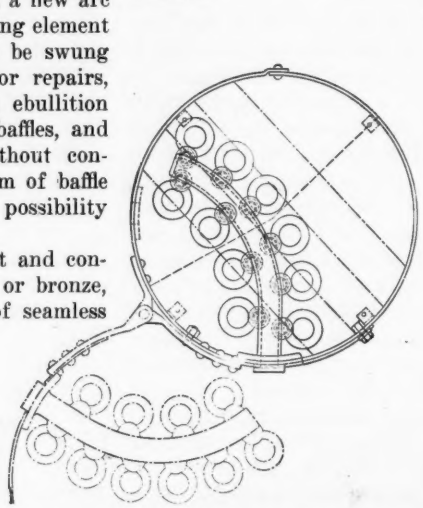

FIG. 2. PLAN VIEW OF R. & D. PARACOIL EVAPORATOR SHOWING METHOD OF SUPPORTING MANIFOLDS AND COILS

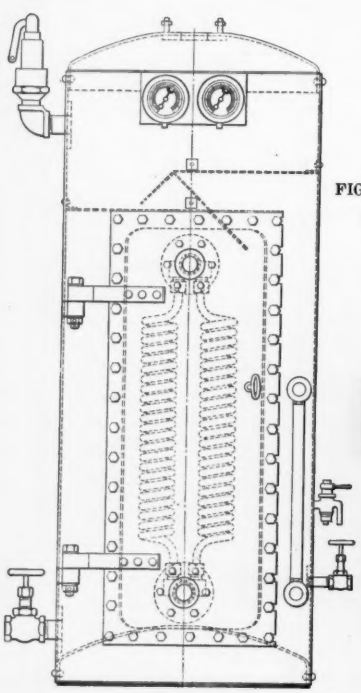

FIG. 1. R. & D. PARACOIL EVAPORATOR

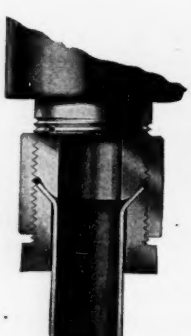

FIG. 3. LOCK NUT CONNECTION

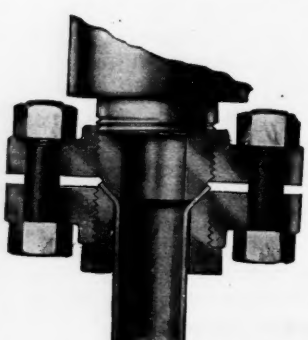

FIG. 4. FLANGE CONNECTION AS USED ON R. & D. PARACOIL EVAPORATORS AND HEATERS

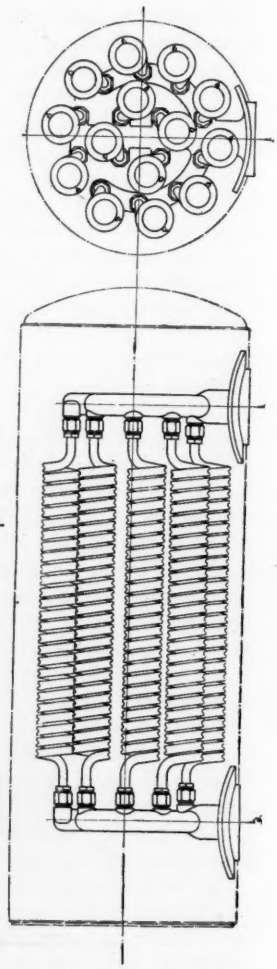

FIG. 5. PLAN AND ELEVATION OF R. & D. PARACOIL FEED-WATER HEATER

Standard sizes of the R. & D. Paracoil evaporator are built up to and including that capable of caring for 50 tons of water per 24 hr.

Essentially the R. & D. Paracoil feed-water heater, which is of the closed type, consists of a shell of open hearth boiler-plate steel, or cast iron, as specified, containing a group of helical seamless drawn copper coils arranged in parallel between inlet and outlet headers. An extra large steel door having the same radius of curvature as the shell provides a means of access to the interior for convenient inspection, cleaning and repair. Standard units are made for installation in vertical position; but where horizontal mounting is desired, the various fittings may be arranged accordingly.

Inlet and outlet manifolds are of cast iron or bronze, of a new segmental type that gives a smooth flow, and are in contact with the shell only at the side where the connections are made. The coils employed are interchangeable, of such form that practically no strain is placed upon the joints, and, due to being corrugated in section, provide ample surface for the transfer of heat. Joints between coils and manifolds are made as indicated in Fig. 3, by slightly flaring the tube end and locking it between a tapered nipple on the manifold and a corresponding brass bushing. The latter is brought up tight by screwing into a brass lock nut that also threads onto the nipple.

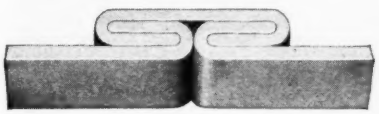

FIG. 1. CONTINUOUS INTERLOCKING SEAM

Steam and water connections are flanged and drilled, the former to conform with the A. S. M. E. low-pressure standard and the latter with the A. S. M. E. extra-heavy standard. For pipe diameters of 2 in. and less, the openings are tapped. Suitable openings are also provided for drain, water gage, safety valve, relief and pressure-gage connections.

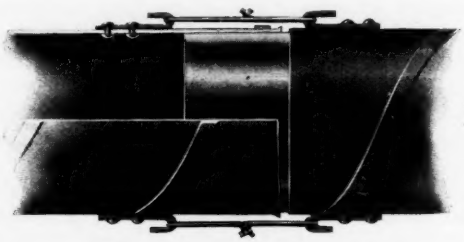

FIG. 2. SLIP SLEEVE CONNECTION

R. & D. Paracoil evaporators and feed-water heaters are marketed by Row & Davis, Engineers, Inc., 90 West St., New York.

GEO. M. THOMPSON, who has been with The France Packing Co. for the past 6 yr., has been placed in charge of all the company's offices on the coast; in Vancouver, B. C.; Los Angeles and San Francisco, Calif.; Seattle, Wash. The San Francisco Branch is in charge of Charles S. Follett, an engineer experienced in both marine and stationary plants.

Standard Reinforced Spiral Pipe

STANDARD Reinforced Spiral Pipe made as required from soft open hearth steel, American ingot iron, toncan metal or other rust resisting pipe, is especially adapted to water supply lines, ventilating or vacuum cleaning systems, dust or shavings collecting systems, as smokestacks, exhaust steam lines, filtration pipes, culverts, etc.

In the making of this pipe which is neither welded or riveted, 2 strips of steel of different widths are employed which are rolled to shape on the edges. They are then interlocked as shown in Fig 1 and rolled down under high pressure, thus providing 4 thicknesses of metal at the point where the reinforcing band passes around the pipe in the form of a continuous spiral seam. This form of construction results in the seam becoming tighter as the internal pressure increases and due to the absence of rivets, collection of particles is eliminated and internal friction reduced to a minimum.

Bitumite coating which readily resists the action of acids, alkali and other corrosive or destructive elements found in air, water and soils is applied to the pipe as a preservative after all scale or signs of oxidation have been removed and the necessary connections such as flanges, slip sleeves, etc., have been attached.

FIG. 3. STANDARD REINFORCED SPIRAL PIPE

Any one of three types of joints may be employed in connection with this piping; namely, the slip sleeve joint, that known as the BB joint and regulation steel flanges welded on to the ends of the pipes. With the former, a seamless sleeve welded into one end of each length of pipe joins the sections to be connected in the manner shown in Fig. 2, the pipes being held together by means of wires attached to holding lugs.

The pipe and fittings for it are manufactured by the Standard Spiral Pipe Works, 4801 So. Rockwell St., Chicago.

The Falls Efficiency and Safety First Club

WITH THE OBJECT of creating at once a capable body of men to suggest and carry out safety recommendations, to plan and create methods whereby plant efficiency may be increased, and last, to promote a sincere feeling of good-fellowship between employer and employe, there has recently been organized at the plant of the Falls Machine Co., Sheboygan Falls, Wis., The Falls Efficiency and Safety First Club.

Commenting on this new organization, J. Geo. Lude, assistant secretary of that company, states: "We want our employes to think and act for themselves. We encourage them to do this. Their responsibility is our responsibility, and if they are of proper calibre, absolutely nothing prevents their attaining any goal they strive for in our organization.

"Our club is a very successful part of the organization, it has proven of immense benefit to all in a good many ways, and as it grows, its value to this corporation will become greater.

"In conducting our meetings, which occur once each month, we invite and expect discussions from all members. Any recommendations or suggestions are passed upon immediately. We also invite and secure the services of specialists in safety work, liability insurance, etc., to address the Club on subjects peculiar to them and of general interest to all members."

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC.

required by the Act of Congress of August 24, 1912, of Practical Engineer, published Semi-Monthly at Chicago, Ill., for April 1, 1917.

State of Illinois } ss.
County of Cook }

Before me, a Notary Public in and for the State and county aforesaid, personally appeared Chas. Sanford Clarke, who, having been duly sworn according to law, deposes and says that he is the Secretary of the Practical Engineer, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

Name of— Post-Office Address—

Publisher, Technical Publishing Co., 537 S. Dearborn St.
Editor, Arthur L. Rice, 537 S. Dearborn St.
Managing Editor, Arthur L. Rice, 537 S. Dearborn St.
Business Manager, E. R. Shaw, 537 S. Dearborn St.

2. That the owners are: (Give names and addresses of individual owners, or, if a corporation, give its name and the names and addresses of stockholders owning or holding 1 per cent or more of the total amount of stock.)

E. R. Shaw, 537 S. Dearborn St.
Arthur L. Rice, 537 S. Dearborn St.
Chas. S. Clarke, 537 S. Dearborn St.
C. B. Leech, 1472 W. Clifton Blvd., Cleveland, Ohio.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.)

There are none.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company, but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other persons, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

5. That the average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the six months preceding the date shown above is.....

(This information is required from daily publications only.) Chas. Sanford Clarke, Sec'y.

Sworn to and subscribed before me this 31st day of March, 1917. Warren A. Lathrop, Notary Public.

[SEAL] (My commission expires October, 1918.)

NOTE.—This statement must be made in duplicate and both copies delivered by the publisher to the postmaster, who shall send one copy to the Third Assistant Postmaster General (Division of Classification), Washington, D. C., and retain the other in the files of the post office. The publisher must publish a copy of this statement in the second issue printed next after its filing.

Civil Service Examinations

U. S. CIVIL SERVICE EXAMINATIONS are announced as follows: (1) Assistant Inspector of Hull (Wood) Construction; (2) Draftsman; (3) Mechanical Engineers. Competitors will not be required to report for examination at any place. Applications should be filed at the earliest possible date; they will be rated immediately upon receipt and appointment made promptly. Apply for Form 1312, stating the title of the examination desired.

U. S. CIVIL SERVICE COMMISSION announces an examination, May 8, for mechanical draftsman. Vacancies occurring in the Bureau of Yards and Docks, Navy Department, Washington, D. C., and at any navy yard or other naval establishment, at entrance salaries ranging from $3.52 to $6 a day, will be filled from this examination. Competitors will be rated on education, preliminary training and experience. The drafting experience must have been in connection with power plant, heating, and ventilating equipment. Applicants must have reached their twenty-first birthday on the date of the examination. Apply for Form 1312.

U. S. CIVIL SERVICE COMMISSION announces an examination, May 15, for radio draftsman. Present and future vacancies in the Navy Department, Washington, D. C., and at any navy yard or other naval establishment, at entrance salaries ranging from $3.04 to $6 a day, will be filled from this examination. Duties require the origination and design of apparatus, switchboards, machines and appliances used in radio communication, plans of their installation, estimating, checking plans, etc.; writing up descriptions of the apparatus indicated. Competitors will be rated on education, training, experience and fitness. Applicants for this position must have had the equivalent of a high-school education and 2 yr. experience as a draftsman, at least 6 mo. of which was upon the design of radio apparatus and radio installations. A bachelor of science degree from a school of recognized standing will be accepted in lieu of 1 yr. of the required experience. Applicants must have reached their twenty-second but not their thirty-fifth birthday on the date of the examination. Apply for Form 1312.

U. S. CIVIL SERVICE COMMISSION announces an examination for mechanical draftsman. Vacancies occurring in the office of the Chief of Ordnance, War Department, Washington, D. C., at entrance salaries ranging from $1000 to $1400, will be filled from this examination. As the supply of eligibles resulting from recent examinations has not been equal to the demand, qualified persons are urged to apply. Until further notice, applications will be received at any time and the papers will be rated immediately upon their receipt, in order that appointments may be made with the least possible delay. Competitors will be rated on general education, technical training, experience, and practical tests rated on work submitted. As a prerequisite for eligibility the applicant must show that he has graduated from a 4 yr. course in engineering from a college of recognized standing or that he is a senior student and expects to graduate within 6 mo. from the date of making oath to his application; or that he has had at least 3 yr. experience as a mechanical draftsman. Each applicant must state in his application the names and addresses of not less than 2 nor more than 5 persons who can testify regarding technical training and experience. Applicants must have reached their eighteenth birthday on the date of making oath to the application. Apply for Form 1312.

Catalog Notes

UNIVERSITY OF WISCONSIN Preliminary Announcement of the Summer Session, June 25 to Aug. 3, 1917, is being sent out. College of Engineering Courses include Chemical, Electrical and Hydraulic Engineering, Machine Design, Mechanical Drawing, Mechanics, Shop Work, Steam and Gas, and Topographical Engineering.

ITINERARY of the eastern inspection trip taken by four instructors and the fourth-year students in mechanical and electrical engineering of the Ohio State University, spending 2 days in Cleveland, 2 in Pittsburgh, 2 at Niagara Falls, and 1 day in Buffalo and Erie, was recently published in bulletin form by the University.

DIAMOND SOOT BLOWERS for Babcock & Wilcox Boilers, is the title of Bulletin 125 recently issued by Diamond Power Specialty Co., of Detroit. It contains a statement from the Babcock & Wilcox Co., explaining why that company has adopted Diamond soot blowers as standard equipment for all boilers it builds. The descriptive matter regarding the application of the mechanical soot blower to B. & W. boilers is clearly illustrated by pictures and drawings. The installation of mechanical soot blowers on the 2365-hp. double Stirling boilers at the Detroit Edison Co.'s Connors Creek plant is also illustrated.

A copy of Bulletin 125 will be sent free to anyone requesting it.

ABOUT A YEAR AGO there appeared in several of the technical journals an account of a test on a centrifugal pump installed at the low level pumping station of the City of Montreal, showing a duty considerably above any previously recorded for steam-turbine-driven centrifugal pumps. In answer to certain criticisms as to the method of figuring the duty, which was based upon the total heat taken by the turbine from the boiler, rather than the amount of steam used, and also regarding the omission of certain data from the test report, an article was prepared by A. Peterson, an engineer of the De Laval Steam Turbine Co., of Trenton, N. J., which the latter company has now reprinted and is distributing in booklet form. The use of net B.t.u.'s as the basis upon which to calculate duty is defended upon the grounds that the user is interested in obtaining the most foot pounds from a given amount of heat, rather than the smallest weight of steam. It is shown that a heat cycle which may appear more efficient upon the basis of steam used, may at the same time be the less efficient upon the basis of heat used. Users of steam turbines will be interested in the detailed analysis of the turbine performance.

POWELL VALVES, particularly the "White Star" valve, are described and illustrated in a circular from The Wm. Powell Co., of Cincinnati, O.

CIRCULAR 104, just issued by Dean Bros. Steam Pump Works, of Indianapolis, explains the advantages of the company's Durable duplex pump.

SAFETY FIRST ironclad switch condulets are described and illustrated in Bulletin No. 1000G, cancelling Bulletin No. 1000D of Crouse-Hinds Co., Syracuse, N. Y.

HUBER HAND STOKERS, manufactured by The Flynn & Emrich Co., Baltimore, Md., are illustrated and described in a recent circular from Brennan Wahl Co., 36 W. Randolph St., Chicago.

THE LATEST DEVELOPMENT of the Taylor stoker is discussed in a pamphlet entitled The Taylor Power Pump, just issued by American Engineering Co., of Philadelphia.

ELECTRIC HOUSEHOLD APPLIANCES, most of which may be connected to the ordinary lighting circuit, are illustrated and described in a recent General Electric circular.

SPRACO PRODUCTS bulletin No. 501, of Spray Engineering Co., 93 Federal St., Boston, Mass., illustrates and describes briefly the company's various lines, serving as a general catalog.

THE STORY of the One-Piece Boiler Furnace Lining is the title of a new folder illustrating the stages involved in putting in a lining of Betson's Plastic Fire Brick, made by Betson Plastic Fire Brick Co., Rome, N. Y.

ACCESSORIES for use on railways, including circuit-breakers, fuse boxes, resistors, connectors, receptacles and plugs are described and illustrated in Catalog 5-B, just issued by the Westinghouse Electric & Manufacturing Co., as a section of its General Supply Catalog. Illustrations are also given of the Rico Coasting Time Recorder which records the actual number of minutes that an electric car or train is operated while coasting, without the use of power or brakes.

TWO INTERESTING BOOKLETS have been received from The M. W. Kellogg Co., of New York, which

are in story form, well illustrated, and may be had for the asking. The booklet, "The Story of a Modern Chimney," is to impress the reader with the important place the chimney has occupied in ancient history; and the second booklet, "The Building of a Modern Chimney," is to show its development and impress the really vital problems involved in its construction; in short, to make people realize that the chimney is much more than just bricks and mortar.

ROW & DAVIS, Engineers, Inc., 90 West St., New York, has just published two interesting bulletins:

The R & D Paracoil Evaporator, Bulletin No. 51, for single or multiple effect operation. The bulletin describes the evaporation thoroughly, illustrating the patented new type of manifold, which is mounted on a hinged door to facilitate inspection, cleaning, etc.

Bulletin No. 52, The R & D Paracoil Feed Water Heater fully describes the shell, manifolds, coils, connections and fittings of this heater.

Trade Notes

SINCE APRIL 1 the Power Efficiency Corporation has been located at 102 Clinton St., Buffalo, N. Y.

COPPUS Engineering & Equipment Co., of Worcester, Mass., has purchased property formerly owned by the Hill Drier Co., on Park Avenue, consisting of nearly an acre of land, two 4-story brick buildings containing approximately 30,000 sq. ft. of floor space. The increased demand for the Coppus Turbo Blower for forced draft for boilers and the other products manufactured by the company made it necessary to select larger quarters. The company also expects to manufacture another line of apparatus which will be announced later. The lower floor in one of the buildings will be utilized for an engine and boiler room and a modern washroom for the employes, steel lockers, and shower bath. The lower floor in the other will be utilized exclusively as a testing laboratory, while the other floors of the two buildings will be used for offices and manufacturing. On part of the vacant land the company plans to erect a modern gray iron foundry and their present brass foundry will be removed.

CONTRACTS totaling approximately $2,000,000, have been placed recently with the Westinghouse Electric & Mfg. Co., of East Pittsburgh, Pa., by the New York Shipbuilding Co., for furnishing the necessary electrical equipments for the propulsion of the new superdreadnaughts Colorado and Washington.

The equipments to be furnished are practically duplicates of that contracted for by the Navy Department for the U.S.S. Tennessee now building at the New York Navy Yard. The 4 propellers, as in the case of the Tennessee, instead of being mechanically connected to driving engines or turbines, are to be driven by individual motors. The current for the motors will be furnished by 2 turbine generators.

In addition to the main generating equipments and propelling motors, the contracts include auxiliaries for the main turbine generators and smaller auxiliary turbine generators for supplying light and power throughout the ships. Westinghouse electric motors will also be utilized for doing nearly all the work on board from raising the anchor to steering.

PRACTICAL ENGINEER

Trade-mark, Reg. U. S. Pat. Off.

PUBLISHED ON THE FIRST AND FIFTEENTH OF EACH MONTH.

SEMI-MONTHLY

Subscription price in advance in the United States, Mexico or united possessions, $1.00 a year.

In Canada, subscription price, $1.75 a year.

Foreign Countries, subscription price, $2.50 a year.

Address all letters and make all checks and money orders payable to Technical Publishing Co., 537 S. Dearborn St., Chicago, Ill.

Any advertiser is invited to examine our paid subscription lists and Post Office mailing receipts at any time.

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Full page, one year, each insertion, $66.00.

Half page, one year, each insertion, $38.50.

Quarter page, one year, each insertion, $22.00.

Eighth page, one year, each insertion, $13.25.

Front cover, $175.00 per issue.

Other specified positions, regular rate plus 10 to 50 per cent.

Stippled plates used, but no heavy, black and white plates.

Classified Rates

Per line, 30 cents each insertion.

Advertisements in this section are inserted under regular headings.

No display type allowed, but the first three words may be set in capital letters.

About nine words make a line. Minimum space sold, two lines.

Under classification "Position Wanted," advertisements not exceeding four lines will be inserted once for subscribers free of charge.

All copy should be received at Chicago office 18 days before date of publication.

Circulation of this issue, 22,000.

Technical Publishing Co.

537 S. Dearborn Street

Chicago

Position Wanted

POSITION WANTED—By young man 21 yrs. in a power plan of 1000 k.w. or more where there is a good chance for advancement. Not particular about wages or kind of work to start with. Have had a year's experience night engineer in 25 kw. plant and one year as head of 200 hp. heating plant. Can furnish best of references. Strictly sober. Am anxious to learn, but patient. Address Box 200, Devil's Lake, N. D.
4-15-1

POSITION WANTED—I am a thoroughly competent power plant engineer, accustomed to handling on high efficiency basis all types of steam engines and turbines, A.C. and D.C. machines; stictly sober; 34 years old, married. Want charge of good plant in Chicago that will pay at least $25.00 per week. Address Box 478, Practical Engineer, 537 S. Dearborn St., Chicago. 5-1-1

POSITION WANTED—By man, 30 years old, good habits, married, with 6 years' experience in steam electric plants. Would like position as engineer in plant of 2500 k.w. capacity or more, where I can advance myself. Address Box 471 Pracical Engineer, 537 S. Dearborn St., Chicago. Illinois. 5-1-1

POSITION WANTED—Young man, age 28, as engineer in New York or Brooklyn. Hold marine, stationary and refrigeration license. Day work, 8-10 hours, desires to go to school nights. Write for particulars. Box 452, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. 5-1-1

POSITION WANTED—As oiler, by young man, age 21, single. Willing to accept position in any city. Address Peter Stanys, 670 W. 18th St., Chicago, Ill. 4-1-3

POSITION WANTED—As Fireman or Oiler in large plant; 3 years, experience as fireman, 18 months as assistant engineer. Married. Strictly sober. Prefer Southern States. L. C. Drake, Cambridge City, Ind. 5-1-1

POSITION WANTED—As chief engineer in industrial plant, Missouri, Arkansas, Kansas, Iowa or Nebraska, or as Superintendent of light and water plant in city of 2500 to 8000. Ten years' practical experience with steam, electrical and water systems. Technical training. Now employed by U. S. Government as engineer and instructor. Executive ability. Can report on 15 to 30 days' notice. Married. Age 30. Address Practical Engineer, Box 466, 537 S. Dearborn St., Chicago, Ill. 5-1-1

POSITION WANTED—By young man, 23 yrs. old, as fireman or oiler in ice and electric light plant in City of St. Louis. Have had one year's experience in firing and some experience in steam engineering. Address Leonard Ochs, 1536 Papin St., St. Louis, Mo. 4-15-2

POSITION WANTED—As engineer in small power plant. Five years' experience as engineer in grain elevator. Good mechanic. Steady and sober habits. Single. 28 years old. Central states preferred. Box 115, Walcott, Iowa.

Help Wanted

WANTED—Resident subscription agents in the following cities: Atlanta, Ga.; Cincinnati and Columbus, Ohio; Kansas City, Mo.; Los Angeles, Cal.; Louisville, Ky.; Newark, N. J.; New Orleans, La.; Portland, Ore.; St. Louis, Mo.; San Francisco, Cal. Washington, D. C. This is an excellent chance for a hustler who is familiar with power plant conditions, to turn his spare time into dollars. To such a one we offer a Real Opportunity. Write Subscription Department, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. tf.

Wanted

WANTED—Agents on commission to sell our shaking grates. We will install grates on trial or put it to test at our expense with any grate made. Address Armstrong Mfg. Co., Springfield, Ohio. tf.

WANTED—Agents handling engine and boiler room specialties in every section for side line paying large commissions. Give experience, line carried and territory covered. Box 381, Practical Engineer, 537 S. Dearborn St., Chicago, Illinois. tf.

WANTED—Men calling on the steam trade to introduce and sell "The worst enemy boiler scale ever had." Good territory and a good proposition open to live men who will work. The Rogers-Collins Co., Pontiac Bldg., St. Louis, Mo. tf.

For Sale

FOR SALE—One 45-hp. Mass. standard Ames Iron Works vertical boiler, 48 in. diameter by 10 ft. 6 in.; never used. The Shaffer-Marsh Company, 35 High St., Hartford, Conn. 5-1-2

For SALE, in North Dakota town of 1000 population, electric light and power plant. Twenty-four-hour service. Plant in good condition. Distribution system covers entire town. Extensions well cared for. Good feed mill business in connection. Price, $30,000. Terms, one-third cash, balance to suit at 5 per cent interest. Address Box 474. Practical Engineer, 537 S. Dearborn St., Chicago, Ill. 3-15-4

FOR SALE—C. H. Wheeler surface condenser, 200 sq. ft. surface. Used in discharge line with 40-lb. water pressure. Water openings flanged 12-in. Approximately 7 ft. long, 30 in. diam. overall dimensions. Mullen air pump 4 in. x 8 in. by 6 in., both in perfect shape. Just replaced by larger units. Paducah Water Company, Paducah, Ky. 4-15-2

FOR SALE—One 60-in. x 16-ft. return flue steam boiler, new licensed by the Ohio Boiler Commission to carry 98 lbs. pressure; in good condition, complete with front and usual fittings and smoke stack that has been used for two years. Price, $300.00 f.o.b. cars here. Address The DeGraff Canning Co., DeGraff, Ohio.

FOR SALE—180-kv.a. G. E. 3-ph., 60-cyc., 220-440-v. alt. d.c. Harrisburg Fleming engine, $2500. 12 x 24 Allis-Chalmers heavy duty tangye frame engine, $500. 50-hp. Muncie oil engine, $800. Power Machinery Exchange, Inc., 1 Montgomery St., Jersey City, N. J. 5-1-1

Patent and Patent Attorneys

PATENTS THAT PROTECT AND PAY—Advice and books free. High references. Best results. Promptness assured. Send sketch or model for search. WATSON E. COLEMAN, Patent Lawyer, 624 F St., N. W., Washington, D. C. tf.

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. Washington, D. C. tf.

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 606 F St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had and the exact costs. Send for full information. tf.

A. P. CONNOR, Consulting Electrical and Mechanical Engineer, Attorney-at-Law and Solicitor of Patents and Trade-Marks. Results guaranteed. 121 Carroll St., S. E., Washington, D. C. tf.

PATENTS — Send sketch for free search and reports. Books and patents and book of reference letters sent free. John S. Duffie & Co., 612 F St., Washington, D. C. tf.

PATENTABLE IDEAS WANTED—Send for three free books. R. B. Owen, 28 Owen Bldg., Washington, D. C. tf.

Technical Books

FREE ENGINEER BOOKS and power plant tools and specialties, for securing new subscribers for Practical Engineer. A dandy chance for the engineer with a little spare time, to get some fine premiums. Send for free descriptive circular and terms. Subscription Department, Practical Engineer, 537 S. Dearborn St., Chicago, Ill.

Miscellaneous

ENGINEERS, DO YOU WANT to utilize your exhaust steam for heating or drying purposes without back pressure on your engine? If so, address Monash Engineering Co., 1413 Jackson Blvd., Chicago, Ill. tf.

Sparks From The Advertising Pages

The following letter was received recently from one of the great family of Practical Engineer readers:

"Some years ago a young lad strolled into my engine room with the unmistakable air of those who "infest a power plant to see the wheels go round." He "gaped" around awhile and I continued reading, watching him once in a while out of the tail of my eye to see that he didn't fall into the flywheel or get across the 550 anywhere. By and by he strolled over to me and after exchanging "howdys" commenting on the weather, etc., began to give me the surprise of my life. He asked my opinion on everything in a power plant from the watchman's alarm clock to our latest flow meters, which were then a new thing on the market. That boy asked a million questions more or less and never made a break. He kept me humping right along on high to keep within sight of his dust. After the catechism was over I asked with respect in my voice where he was Chief, wondering all the while how one so young could have had so much experience.

"Well," he grinned in an embarrassed way, "just now I'm firing a 'portable' out in the woods, but I'm studying all the time and take Practical Engineer and keep posted on all the new stuff that comes out and I don't 'figger' to fire that 'portable' forever."

Well, he didn't, and where he is now he don't have to "figger" whether he can afford a peck of potatoes or a quart of beans, and that's going some."

There are many readers of Practical Engineer who have undergone the same process of development as the young fellow mentioned above—and who now occupy remunerative berths such as superintendent — chief engineer — master mechanic, etc. Success after all is simply looking far enough ahead and making the necessary preparation—it is foresight backed up by energy and intelligence. Many a failure at 40 would have been a success if he could have foreseen failure while he was yet 20.

Keeping posted on the new equipment is one thing that the man mentioned above emphasized. He was a "comer" then—he has "arrived" now. He knew the principle of evolution and understood the eternal changing of things. He appreciated the wisdom of Pope's remark:

"Be not the first by whom the new is tried
Nor yet the last to lay the old aside."

The man who buys advertised goods strikes the happy medium. What he buys is past the experimental stage, and is modern enough to compete with up-to-date business methods. Read carefully the advertising pages of Practical Engineer and send for the literature on any device you want to become posted on. In courtesy to the advertiser, mention the fact that you saw his advertisement in Practical Engineer.